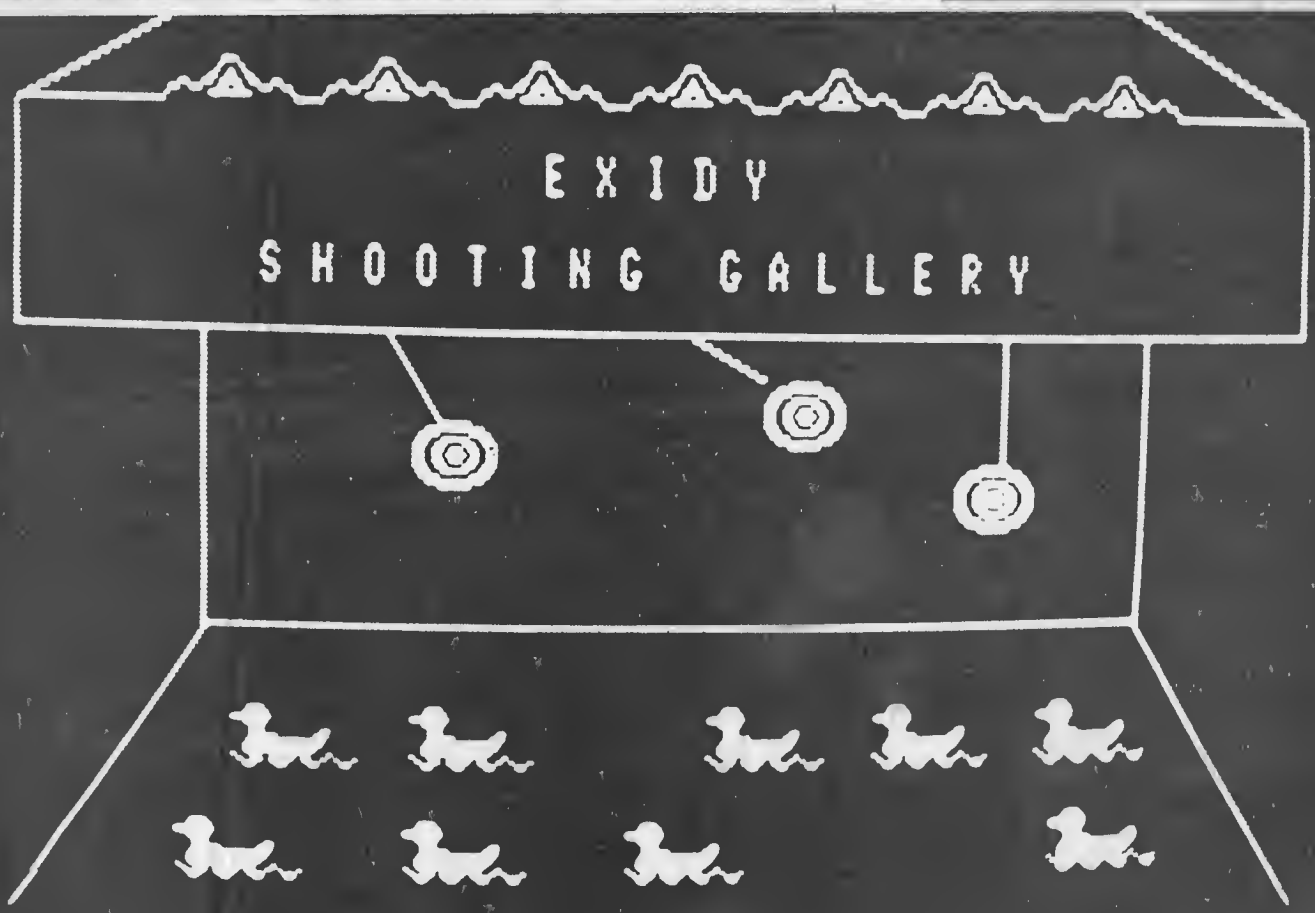
computing today

No 4

February 79

THE NEW MAGAZINE FOR SMALL SYSTEMS WITH BIG IDEAS.....



Bally Video Game and Exidy Sorcerer Reviewed

Program Development for MPU Users

Softspot

Presented as a supplement to ETI.

computing today

No. 4 February 1979

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HAPPY MEMORIES

ASCII KEYBOARDS £49

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All 128 ASCII characters, parallel output, 2 key rollover, Alpha lock, Auto-repeat, Two user-definable keys, positive and neg. strobe, All on 12½ x 6 inch PCB. Add-on five key cursor kit for up, down, left, right and home available. Send SAE for data sheet.

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- ★ Initial quantities limited.
- ★ Available early January.
- ★ Phone or write for full details.
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DKH641 Dual Minifloppy System
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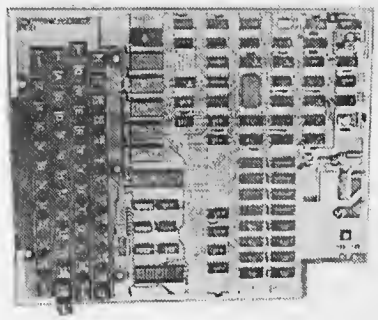

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to $2000. It is more powerful than computer systems which cost over $20,000 in the early 1970's.

This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the President of the United States to tutoring trigonometry all possible by its fast extended BASIC graphics and data storage ability.

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Standard Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
- Full feature BASIC runs faster than currently available personal computers and all 8080-based business computesr.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper-lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters, without overscan up to 30 x 30 characters.

Extras

- Available expander board features 24K static RAM (additional mini-floppy interface, port adapter for printer and modem and OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

Commands
CONT LIST NEW NULL RUN

Statements
CLEAR DATA DEF DIM END FOR
GOTO GOSUB IF...GOTO IF...THEN INPUT LET
NEXT ON...GOTO ON...GOSUB POKE PRINT READ
REM RESTORE RETURN STOP

Expressions
Operators
—, +, *, /, ↑, NOT, AND, OR, >, <, <>, >=, <=, =
RANGE 10^{-32} to 10^{+32}

Functions
ABS(X) ATN(X) COS(X) EXP(X) FRE(X) INT(X)
LOG(X) PEEK(I) POS(I) RND(X) SGN(X) SIN(X)
SPC(I) SQR(X) TAB(I) TAN(X) USR(I)

String Functions
ASC(X$) CHR$(I) FRE(X$) LEFT$(X$,I) LEN(X$) MID$(X$,I,J)
RIGHT$(X$,I) STR$(X) VAL(X$)

Plus variables, arrays and good editing facilities.

Fully built and tested. Requires only +5V at 3 amps and a videomonitor or TV and RF converter to be up and running.

There is enormous interest in Superboard, so order early if you wish to avoid inevitably long delivery dates later this year.

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Name .....

Address .....

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ETI 1

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SOUND

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(Phone for appointment)

News

Hot Printer

The low cost, about £175, thermal printer from Bowmat joins the ranks of the low cost peripherals designed for small systems.

The TP-3150-2 features a single chip MPU to control print operation, resulting in a versatile device that can accept data is parallel or serial form with print direction and character rotation controllable by tying control pins to an applropriate level.

The printer produces the standard ASCII character subset as well as recognising line feed, carriage return and back space control characters. An integral 32 character buffer to speed parallel loading rounds off an impressive specification.

The mechanisms does not include a power supply, but for the low asking price you can't have everything.

Petsoft Programs

Petsoft, PO Box 9, Newbury, Berks, are producing an ever expanding range of software for the popular PET microcomputer. Their latest list of additions to their range include titles ranging from a program for solving linear programming problems (constrained maximization) using the simplex method to a package that draws a maze on the PETs screen from which the user must escape.

All existing titles have been reduced in price by 8% and an SAE to Petsoft should secure you their catalogue which should make an interesting read.

Petsoft are also offering, for £10.75, a battery-powered head demagnetizer packed inside a cassette shell. This gets over the problems of residual magnetization of the cassette deck's heads without endangering the safety of any program
cassettes in the vicinity of PET when the device is used.

Elf 'Ere

H. L. Audio Ltd of 9B Garman Road, London, N17 0UR, are now offering the ELF 11 MPU Development Kit to the UK market. The system, very popular in the States, offers a hex keypad, LED display plus support components to implement a minimal RCA 1802 MPU test bed. An interesting feature is the ability of the ELF to generate alphanumeric or graphics characters on a TV screen in even its basic form.

PET Pieces

WITH thousands of PETs in the field the business of providing expansion boards for the basic machine looks an attractive proposition and many people are providing a range of interesting add ons for the beast. These range from the frivolous, PET music box, to the more meaty memory expansion boards and floppy drives.

Commodore themselves carry information on the increasing range of products in their excellent Users Club letter. Another company with a news sheet detailing PET goodies is Lotus Sound of 4 Morgan Street, London, E3 5AB.

Lotus sell the above mentioned music box that allows one to compose up to 90 pages of music, a page being 16 notes. Some attractive sounding noises can be produced with this little box that, when used with PET, allows quite comprehensive editing and formatting of the musical material.

The device also allows sound effects to be added to existing programs.

On a more serious note (sic) Lotus supply expansion memory boards in 16K, 24K and 32K increments.

The mother board fits inside the PET and runs off the unregulated DC supply of the machine. As the 32K Expandapet (what else could it be called) uses less power than 4K of standard PET memory, overloading of the PET's PSU is not a worry.

There are four slots for daughter boards on the main Expandpet board into which can be plugged EPROM boards (2 x 2780 + 2 parallel I/O parts), S100 I/O driver boards, and experimenters' boards (a blank card providing an area for the development of custom circuits).

The mother board will also take the connections to the DKH641 dual floppy drive unit.

This comes complete with cabinet and mains power supply — connect to Expandapet and you're up and running.

The unit features two 5½in single sided disks providing about 100K of storage on each.

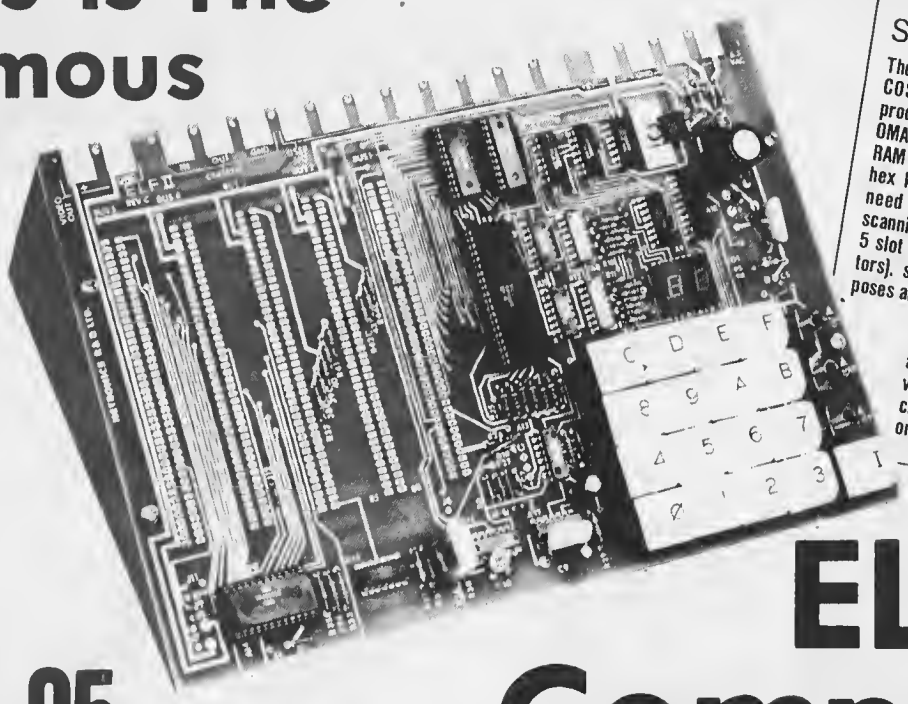
It will support the Centronic as well as PET printers and offers the commands shown below:—

Oh — the price — £916 plus VAT.

For more details of the above write to Lotus enclosing an SAE.

● DIR	Display contents of disk directory
● FORMAT	Formats a blank diskette
● MEM	Display memory
● SAVE	Save program on disk
● LOAD	Load program from disk
● ERASE	Erase file from disk
● GO	Run machine langugage program
● NEW	Reset machine language program pointers
● PRNT	Commercial printer support
● ODISK	Open disk DATA file
● CDISK	Close disk DATA file
● RDISK	Read disk DATA file
● WDISK	Write disk DATA file
● XEQ	load and run program overlay

This Is The Famous



SPECIFICATIONS

The £99.95 ELF II computer features an RCA COSMAC COS/MOS 1802 8-bit microprocessor addressable to 64k bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM expandable to 64K bytes, professional hex keyboard fully decoded so there's no need to waste memory with keyboard scanning circuits, built-in power regulator, 5 slot plug-in expansion bus (less connectors), stable crystal clock for timing purposes and a double-sided, plated-through pc board plus RCA 1861 video IC to display any segment of memory on a video monitor or TV screen along with all the logic and support circuitry you need to learn every one of the RCA 1802's capabilities.

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But that's not all, once you've mastered computer fundamentals ELF 11 can give you POWER with add-ons that are among the most advanced found anywhere American 1EEE chapters plus hundreds of universities and major corporations have chosen the ELF 11 to introduce their students and personnel to microprocessor computing!

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Keyed specifically to the ELF 11, it's loaded with 'hands on' illustrations When you're finished, ELF 11 and tho 1802 will no longor hold any mystorios for you

In fact, not only will you be able to use a personal computer creatively, you'll also be be ablo to understand computing articles in the technical press

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ELF 11 s S-card expansion bus (connectors not included) allows you to expand ELF 11 as your need for power grows. If you're an engineer or hobbyist you can also use ELF 11 as a counter, alarm, lock, thermostat, timor or for countless other applications

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NOW BASIC MAKES PROGRAMMING ELF 11 EVEN EASIER!

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The Exidy Sorcerer

Phil Cohen reviews the Exidy Sorcerer — is it another PET or is it something more?

THE SORCERER is a Z-80 based multi-language system. It comes as a moulded plastic case containing CPU, RAM, monitor, keyboard and modems for TV and tape recorder. The price is somewhere around £850. A socket on the side of the case allows the insertion of 8k of ROM in a cartridge form.

First Impressions — Case and Keyboard

The Sorcerer is a *nice* machine. The keyboard is a pleasure to use — very chunky and with a separate numeric keypad. The top of the case is printed with a diagram of the keyboard so that the user can write the positions of his user-defined graphics (more about that later).

The ROM cartridge looks very much like an 8-track tape cartridge — except that it has an edge-connector at the business end. The sockets at the back, as well as TV and tape inputs and outputs, include an RS232 interface (for teletype or similar) and a parallel interface with handshaking. The whole thing can just about be carried under one arm (although at £850-odd a time, I wouldn't recommend it), and it looks very smart indeed. The video output (which can easily be turned into UHF for a few pounds) produces a rock-steady picture giving 30 lines by 64 characters. The character set includes upper and lower case alpha-numerics and a full graphics set including clubs, diamonds, hearts and spades! There are three shift keys:

SHIFT produces the upper case alphabet;
GRAPHIC produces the full graphics set and

CONTROL produces ASCII control characters such as form feed, carriage return and bell. Pressing SHIFT and GRAPHIC together gives the user-defined character set stored in RAM. This can be altered from BASIC or machine code to give a set of 64 8 x 8 dot matrix characters. I don't know off-hand what the number of letters in the Greek alphabet is, but I'm sure it's less than 64! It is also possible to re-define the graphics characters in the same way, giving 128 possibilities.

There are two RESET keys—as a safety feature. Only pressing both at once has any effect. It's little tricks like that that make a machine a pleasure to use and cuts down the amount of profanity in the early stages! There's also a REPEAT key. Normally, a REPEAT key has to be pressed while pressing the character to be repeated. This one's different. When pressed, it repeats the last character to be input; this saves the trouble of pressing SHIFT, GRAPHIC, a letter and REPEAT all at the same time — a feat which is doubtless easy for internationally acclaimed pianists, but which I find a trifle difficult.

Back to BASICS

The BASIC comes in 8k of ROM — this may not seem like all that much, but it's Z-80 CODE, remember!

With the BASIC ROM cartridge plugged in, pressing RESET will give the impressive message:

31976 BYTES FREE.

This is the amount of space available for storing programs, variables or whatever. This is enough for a floating-point array with just under 7 000 elements!

The version of BASIC is similar to that found in the Commodore PET — not surprising since both BASICS were designed by the same software company. The Sorcerer uses standard BASIC line-replacement editing with a colon separating statements on the same line. One thing I found out early on, though, is that the Sorcerer does *not* like long lines. On occasion I have managed to 'crash' the system completely, requiring reset to get any response. This can be achieved by INPUTting a string longer than one line. When writing a line of a program, the Sorcerer will accept up to two lines of

See how easy programming is? Just think of all the applications for this great machine.

Using the Sorcerer is as easy as typing. Try typing the LIST command and you will see your program displayed on the screen.

You must understand the keyboard if you are to have any meaningful conversations with Sorcerer.

The keyboard is similar to a standard typewriter keyboard, with a few additions. The letters and control keys are virtually in the same positions, but for your convenience and speed in numerical computations, a numeric pad is provided (see Figure 3).

Figure 3. The Keyboard (Characters without Shifting)

Since your Sorcerer has both upper and lower case characters, you will find its operation identical to a typewriter. And, since many programs are written only in upper case characters, there is a shift lock key for your convenience.

If you press a key without shifting, you will get a lower case character.

Figure 4. Characters with Shift Lock Key Depressed

When you simultaneously press the SHIFT LOCK key and a letter, you get the upper case representation or notation as shown in Figure 4.

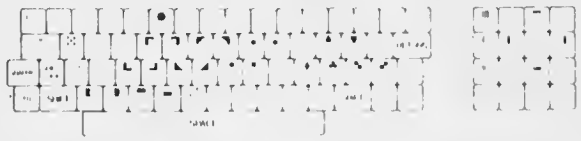


Figure 5. Characters with Shift Lock and Graphics Keys Depressed

When you simultaneously press the SHIFT LOCK key, GRAPHIC key, and letter you get the graphic symbol shown in Figure 5.

The graphic symbols shown on the key tops are a special defined set for Sorcerer. They are used to draw pictures, lines and bar charts on the screen. They can be used just like any other letter or digit on the keyboard.

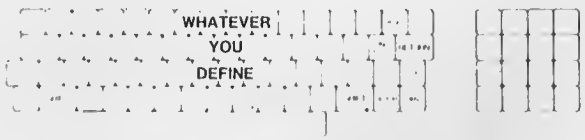


Figure 6. Characters with Shift Graphic Key Depressed

Pressing SHIFT and the GRAPHIC key simultaneously with any letter will give you one of your own characters. (See the SPECIAL OFFERING chapter for detailed instructions on how to program your own character set.)

text but will ignore the second line! Although this seems like a major bug, it should be borne in mind that the Sorcerer's lines are 64 characters long and so most programs will not cause any problems.
The system commands are: (Square brackets indicate an optional parameter)

BYE	Hands control over to the monitor.
CLEAR [n]	Clears variable stack. n is the number of bytes available for string storage after CLEAR.
CLOAD name [n]	Loads a program from unit n. (default is cassette) Name is the file name (up to 5 chars). The BAUD rate is software-selectable at 1200 or 300 BAUD (see monitor description).
CLOAD* n name	Loads a numeric array called name from device n. This can be done during a program — very useful for data storage but why not string arrays as well?
CONT	Continues execution at the point it was broken in at (BREAK is achieved by pressing CONTROL and C simultaneously)
CSAVE name [n]	The opposite of CLOAD and CLOAD*.
CSAVE* n name	
LIST [n]	Lists the program either from the start or from line number n. Surprisingly, there's no way to tell it to stop at a specified line, although the listing can be held at its current position by pressing RUN/STOP. This halts the processor until it is released.
NEW	Deletes current program.
NULL n	When using some peripherals, it is necessary to output a number of NULL characters after each carriage return (to give the carriage time to return!) This sets the number.
RUN [n]	Runs at start of program or at line n.

Most of these can be incorporated in a program (putting RUN at the start of a program is not recommended!)

Variables

The variable types are: floating point, string and array. There are no integer variables! Presumably, with 32k of memory to play with, the designers decided that most users wouldn't need the saving possible by using integers rather than floating-point numbers for large arrays. The arrays can be of up to 12 dimensions (in theory, there's no limit — but with a floating point array with each dimension's subscript range equal to 2, 12 dimensions gives 4096 elements).

The string variables can hold up to 255 elements each and the floating point range is 6 significant figures with a range of 1.70141E38 to 2.93874E-39. The six significant figure limit does not, however, apply to arithmetic:

```
10  A=111111111111
20  B=100000000000
30  PRINT A
40  A=A—B
50  B=B/10
60  GOTO 30
RUN
1.11111 E + 11
1.11111 E + 10
1.11112 E + 09
1.11121 E + 08
etc.
```

The results of the above run show that the actual arithmetic accuracy is 7 significant digits. The fact that the 'noise' digit is a 2 rather than a zero leads me to suspect that the storage is in a binary representation of some sort, rather than BCD.

Statements

The Sorcerer supports normal BASIC statements: DATA, DEF, DIM, END, FOR .... NEXT, GOTO,

Figure 7. Characters with Control Key Depressed

Figure 7 shows how you can perform the standard TTY and computer terminal functions, by pressing the CTRL key simultaneously with the designated keys. These functions correspond to ASCII characters 0 through 31. If you are new to personal computing, you can ignore these completely.

Figure 7 also shows which keys control the video monitor cursor. With the CTRL key depressed, either of the HOME keys will put the cursor in home position (upper left corner of the screen), while an arrow key will move the cursor 1 space in the direction of the arrow.

It's about time to give this newly discovered keyboard a workout and there's no better way than by exploring BASIC.

GOSUB, IF .... GOTO, IF .... THEN, IF .... GOSUB, INPUT, LET (optional), ON .... GOTO, ON .... GOSUB, PRINT, READ, REM, RETURN, STOP.
In addition to these it supports:

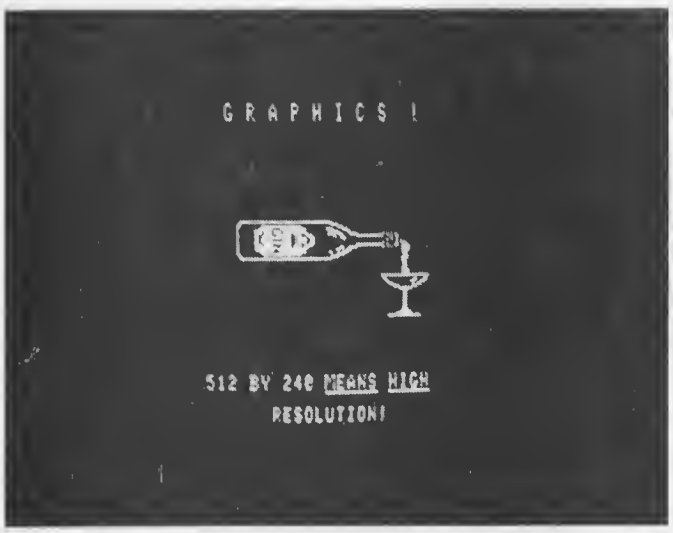
PEEK	Allowing memory to be examined.
POKE	Allowing memory to be changed.
RESTORE	This starts READ at the first DATA statement again, allowing data to be read more than once.
WAIT	Stops execution until a particular bit pattern appears at a specified port — very useful for interfacing with miscellaneous mechanical hardware: limit switches and the like.
OUT, INP	These allow communication via the ports. Double-byte numbers can be sent or received.

Functions

The intrinsic BASIC functions are:
ABS, ASC, ATN (arctan), CHR$, COS, EXP, FRE (amount of memory left), INP, INT, LEFT$, LEN (of a string), LOG (base e), MID$, RND (random number-rectangular distribution), POS (cursor position), RIGHT$, SGN, SIN, SPC (prints spaces), SQR, STR$, TAB, TAN, USR (user-defined machine code subroutine with one parameter), VAL. The accuracy of these was limited by the 6-digit accuracy of the machine:

PRINT 30↑2 (30^2)
900.001
PRINT 2 ↑13 (2^{13})
8192.01

The above represent the two worst errors I could find in about 15 mins, however, the computational accuracy in general was adequate.



Above and right: Examples of the Sorcerer's impressive graphics capability.

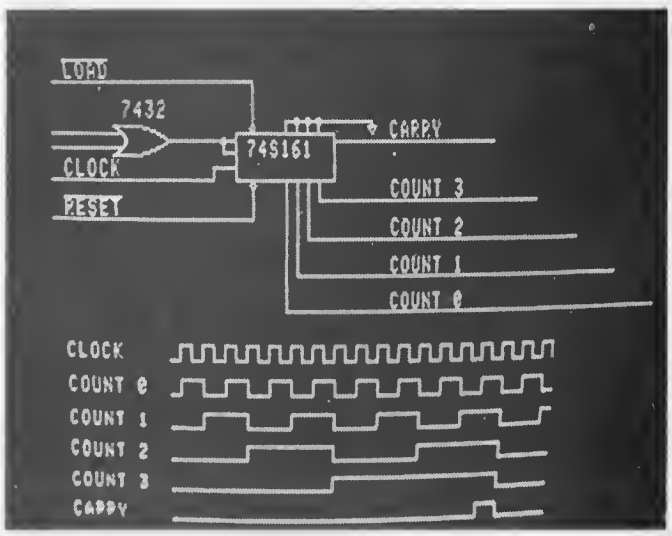
Error Messages and Software Fragility

The error messages are a little cryptic:
? UL ERROR
or SN ERROR IN 20
for example, but they are fully explained in the manual. Anyway, which would you rather have — massive error messages or more functions?

Apart from long lines, the system seems quite stable — I 'crashed' it on only two occasions, one by entering too long a line on INPUTting a string and once by trying to get back into BASIC from the monitor while the ROM was removed! On both occasions, pressing the general reset got me out of trouble.

User-Defined Graphics

These can be changed by POKEing from BASIC or from the monitor. Each character requires eight two-byte numbers to define it and these are put into RAM between FE00 and FFFF, depending on which



character is to be set. For example, to define the shifted graphic character associated with the "I" key (which happens to reside at the bottom of the user graphics RAM) as the Greek letter Omega (Ω), the memory locations FEOO to FEO7 are set to 00, 38, 44, 82, 82, 44, 22 and EE respectively. The bit-patterns of these, when laid out one under the other in sequence, form an Ω (try it, if you don't believe me!). Whenever shifted graphic "1" is used after this has been done, the letter Omega will appear.

The graphics held in RAM can, of course, be stored on tape – so you can have a tape for Greek maths, wargames, or whatever. (By the way, try 3C 7E DB E7 FF 42 7E 3C!)

Monitor

The monitor is 4K (and 4K of Z-80 code is quite a lot!).

The commands are: (Parameters in square brackets are optional)

DUMP n [m]	Displays memory contents from n to m — nice output format.
ENTER n	Allows successive memory locations to be changed, starting with location n.
SAVE name n m [unit]	Saves memory onto tape with from n to m and sends output to the specified unit. The output header will contain the name, begin address, block size, file type and GO address.
LOAD [name] [unit] [n]	Loads file from specified unit. The start address will be the one in the tape header if n is not specified.
FILES [n]	Lists information in headers coming from unit n.
GO n	Calls a program starting at n.
MOVE nl n2 [S]n3	This mirrors the Z-80 move instruction. It can either (depending on whether S is included) move information from nl through n2 to locations beginning at n3, or move n3 locations starting at nl to locations starting at n2.
TEST n m [C]	Used to test RAM locations from n to m — inclusion of C makes it repeat continuously. This must be very useful for fault-finding in newly-completed units.
PROMPT=n	Changes the monitor prompt to character n. Can't see the use for this myself!
CREAT	Causes the creation of a 'BATCH' tape. This is a macro of monitor commands on a tape which can be played back and executed a number of times. This must be to enable full RAM and ROM testing automatically at the factory — other uses would include multi-pass compiler overlay and other exotic applications.
LIST	Lists the BATCH commands from a tape as it is played back.
BATCH	Executes commands from a tape.
OVER	Returns control to the user from BATCH mode. This command would be the last on a BATCH tape.
SET S=n	Sets the delay between each letter output to the display. Used when output is to a slow printer.
SET T=n	n=0 means that the tape modem operates at 1200 baud; n=1 means 300 baud.
SET F=n	Sets file type in tape header store. This is a two-byte number with which the user can label a file in any way he chooses.
SET X=n	GO address in tape header.
SET O=V O=P O=L O=S O=n	Changes output port to video, parallel output, Centronics printer driver, tape or address specified
SET I=K I=P I=S I=n	Sets input port to keyboard, parallel port, tape or specified address
PP	Jumps to plug-in ROM.

A very powerful selection altogether. Exidy hope to bring out a full assembler/editor which, in addition to the above, would make this an excellent development system.

Modem

The baud rate of the modem is software — programmable at 1200 or 300 baud. I subjected it to the acid test — my little portable cassette recorder *with* auto level control!

I had to hand some tapes which had been recorded at 1200 baud on a good machine — these played without a hitch. However, when I tried to record a program at 1200 baud, the Sorcerer couln't read it back — due, probably, to the fact that on small cassette recorders the playback circuitry is better than the record side, due to the availability of pre-recorded tapes.

Anyway, when I tried the same thing at 300 baud it worked perfectly (although slower!).

I couldn't get the machine to accept wrong characters without noticing — I tried various tricks like re-recording file headers, fiddling with the plug on the signal cable and even varying the playback speed mechanically — all of these either:

a) had no effect, or
b) produced an error message.

One rather annoying response, however, was that after aborting an attempt to load a BASIC program, typing LIST caused the same line number (and nothing else!) to be repeated ad infinitum until stopped by interrupt.

The facility for recording arrays of data and replaying them with a single command is nice, if

marred by the fact that (as far as I can tell) it cannot be done with string arrays.

Manuals

The two manuals which are provided (one on the BASIC system and one on the system as a whole) are beautifully produced, although they contained the usual Americanisms which jarred occasionally ("In California the sales tax is 6%. This program will calculate your sales tax on any purchase . . .").

One annoying thing was that these were both learning texts — there's no quick-reference hard information manual. The manuals also leave a few things out — the USR () function (which allows entry to a user-defined machine code subroutine) is mentioned, but not how to tell the machine the start address.

The glossary in one of the manuals is worth quoting:
"PRINTER — a computer output mechanism that delivers hard copy data". Come back, NASA, all is forgiven!

All in all, though, the manuals are very easy to follow and should provide an excellent 'bootstrap' for the beginner, as well as explaining the subtler parts fairly painlessly.

Accessories

At present, the Sorcerer is available with BASIC only. Exidy hope to bring out other ROM packs including a word processor, an assembler/editor and an APL system. The re-definably graphics will prove useful in the latter, no doubt, as APL uses all manner of little squares, circles, dots, arrows and what-have-you.

An S-100 extension will also be available soon from Exidy and this will enable the machine to be expanded ad infinitum.

Summary

The Sorcerer is an excellent machine. What makes it different from the other units on the market is that it is designed for the amateur to use, but has full professional facilities. It would be quite happy linked to a mainframe — it even has the full ASCII control character set.

The BASIC is comprehensive and fast and the memory is massive. The best thing about it, though, is its flexibility. Anything which can be made user-accessible is made so. For instance, it is possible re-define, from BASIC, what size the string storage area is to be. It's this sort of user-transparency makes it so flexible.

The price is not high in comparison to other machines (it's cheaper than a PET with memory expansion).

If you want a machine for a sensible application (process control, invoicing or whatever), then this is a good buy.

The Sorcerer we reviewed was on loan to us from Teleplay (at 14 Station Road, New Barnet, Herts, EN5 1QW).

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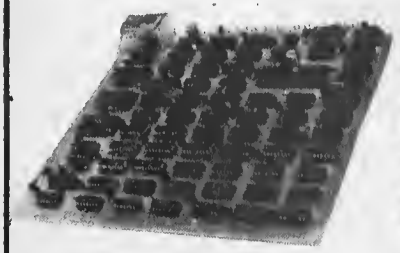

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Program Development

Ron Wilson takes a look at operating systems using MIKBUG as an example.

AT PRESENT there are two approaches to becoming a microcomputer owner:

1. The integrated circuits MPU, ROMS, RAMS, PIA etc are purchased and the user designs his own microcomputer for his application. This method takes advantage of the special circumstances of each application.

2. A complete system is bought which has been designed, and if necessary built and tested. The complete system is of course capable of expansion by the addition of peripherals, extra memory and special purpose interface circuits.

The low component — cost is attractive in case 1 but consider this: WHEN POWER IS FIRST APPLIED WHAT HAPPENS? In both cases some type of **operating system** is needed.

An operating system is a complex program which operates and supervises the running and execution of the computer and other programs within the computer. In case 1 above the user is left to organise his own system and consequently needs to write some type of operating system to govern the system. In case 2 an operating system is usually provided by the manufacturer and for microprocessor systems comes in the form of a pre-programmed ROM.

As an example the features of a system provided by Motorola known as MIKBUG will be considered.

Mikbug

This is a loader and diagnostic control program that is supplied with certain of Motorola's complete systems. This program is contained in a pre-programmed ROM.

The various routines within MIKBUG may be called by entering on the keyboard one of the following single character calls:

L—Load Data into memory
P—Print/Punch Data from Memory
M—Memory Change
R—Display Contents of the CPU Registers
G—Go to Main Programmes

Other features include the capability to set breakpoints with memory change and the use of interrupts.

When power is first applied to a system governed by a MIKBUG operating system an asterisk (*) is displayed on the user's VDU in response to the user pressing the microcomputer RESET button.

The asterisk is very reassuring. Often whilst testing a program under development the system appears to 'die'. The faithful RESET brings it back to life with an asterisk.

The Rôle of Editors and Assemblers in Programming

The importance of the operating system has been considered earlier, however, other software packages are available to shorten the user's design and development cycle. The major packages are

A Source Program Editor and
An Assembler

In developing a program the sequence of events tends to be:

Problem Definition
Obtain Method of Solving Problem
Draw Flowcharts
Write Assembly Language Program
Edit Assembly Language Program
Assemble Mnemonics into Object Code
Run the Program
Correct Errors
Obtain a Record of the Validated Program

The bold sections show where the editor and assembler packages are used. Each computer system has its own editor which helps the user to format his source statements for suitable input to the assembler. The source program written mnemonics needs to be translated into numeric patterns. The resulting data, called object code, is generated from the source code by using an assembler. The input is the source program and the output is an assembly listing and object tape file. This file is normally in the form of a paper tape or cassette tape.

The Use of an Assembler

The manual translation of mnemonics into hexadecimal code is tedious and prone to error. This is particularly the case when calculating the addresses

for the Branch type of instruction. The normal method of programming uses an assembler software package as an aid in order to overcome these difficulties. The method of writing programs needs to be modified slightly to account for the special operation of the assembler program.

The format of the source program is very important. Some sample programs may help to illustrate the essential features.

A Sample Program

```
 NAM 6800RW1
 OPT S, O
*2"S COMPLEMT PROGRAM
 ORG O
 LDAA #O1H LOAD ACC A WITH O1 IN HEX
 COMA FORM 1"S COMPLEMENT
 INCA INC ACC A
 SWI
 END
```

A number of features are noticeable when the program is contrasted with writing directly in hexadecimal.

1. Certain prefixes and suffixes adjoin the program, eg NAM, OPT.
2. Comments have been added.
3. In fact there are separate fields within a program line.
4. A software interrupt SW1 has been used. This is to help in testing the program.

The separate fields within a source statement are LABEL, OPERATOR, OPERAND and COMMENT. The use of labels at the destinations of branch and jump instructions simplifies programs by eliminating the tedious calculations otherwise needed. The mnemonic operator is present in all statements, except when the statement is a comment only, however, the inclusion of an operand field depends upon which mnemonic operator is used. Comments are optional but they are a convenient way of producing a well-documented program.

The successive fields within a statement are separated by one or more SPACE characters.

The Sample Program Assembled

The assembler package when activated responds as shown below. The user then types 1P or 2P to indicate first pass or second pass of the source tape. The procedure in more detail is:

```
M6800 ASSEMBLER VERSION 1.2
ENTER PAS : 1P, 1S, 2P, 2L, 2T

1P
M6800 ASSEMBLER VERSION 1.2
ENTER PASS : 1P, 1S, 2P, 2L, 2T

2P

PAGE    001     6800    RW1
00001                   NAM     6800RWI
00002                   OPT     s,O
00003           *2's    COMPLEMT PRO-
GRAM
00004   0000            ORG     O       LOAD ACC A
00005   0000    86 01   LDA A   0IH     WITH 01 IN
00006   0002    43      COM A           HEX
00007   0003    4C      INC A           FORM 1'S
00008   0004    3F      SWI             COMPLEMENT
00009                   END             INC ACC A

TOTAL ERRORS 00000
```

After the first pass the source tape must again be set so that the beginning of the tape is in a position to be read.

During the second pass through the program, a listing is printed which shows the address in the program counter, and the object code, along with the corresponding source statement (unless the listing is repressed by the "NOLIST" option under assembler directive "OPT" in the source program). Within the listing the errors are noted on the line preceding the source statement, by one or more of the codes.

Output is again shown to be highly structured.

```
 NAM 6800RW2
 OPT S,O
*PROGRAMMABLE COUNTER
 ORG 100
 LDAA #OAH LOAD ACC A WITH TEN

 LDAB #OOH INITIALISE ACC B=O
 BACK INCB INCREMENT B
 CBA COMPARE ACC'S
 BNE BACK BRANCH IF ACC A NOT = ACC B
 SWI
 END
```

This program contains a BRANCH instruction, BNE. A label BACK is used to define where to branch to. The assembled program is as follows:

```
*G
M6800 ASSEMBLER VERSION 1.2
ENTER PASS : 1P, 1S, 2P, 2L, 2T

1P
M6800 ASSEMBLER VERSION 1.2
ENTER PASS : 1P, 1S, 2P, 2L, 2T

2P

PAGE    001     6800RW2
00001                   NAM     6800RW2
00002                   OPT     S,O
0003            *PROGRAMMABLE
                COUNTER
00004   0064            ORG     100
00005   0064    86 OA   LDA     A #OAH  LOAD ACC A
00007   0066    C6 OO   LDA     B #OOH  WITH TEN
00008   0068    5C BACK         INC     B INITIALISE
00009   0069    0069    0069    11      ACC B=O
CAB                                     INCREMENT B
00010   0064    25 FC   BNE     BACK    COMPARE
00011   006C    SWI                     ACC's
00012                   END             BRANCH IF
BACK    0068                            ACC A NOT-
TOTAL ERRORS 00000                      =ACC B
```

In order to understand the listing consider the line
00008 0068 5C BACK INCB INCREMENT B
00008 is the line number
0068 is the instruction address (Program Counter)
5C is the instruction (and operand) field

BACK is the label field
INC B is the operator or mnemonic field
INCREMENT B is the comments field

An asterisk (*) in the first character position of a statement causes the entire statement to become a comment.

As an example — *PROGRAMMABLE COUNTER.

The aim is to use the assembler to obtain a tape of the object code for the program under consideration.

The object tape for the second specimen program has the following characters on it.

S00B000036383030525732202B
S10C0064860AC6005C1126FC3F6B
S903000FC

An advantage of using the assembler program is that knowledge of the exact hexadecimal codes for the program are not necessary. The next main concern is to run and test the program.

Running a Program

The object tape is loaded into the system. In this case the operating system is under the control of MIKBUG so after the computer systems has been reset then L is typed. This reads in the object tape via the teletype.

Before the G command is given the **beginning address of the user's program must be loaded into the program counter from the stack address A048 (MS byte) and A049 (LS byte).** This is a feature of MIKBUG. This is achieved using the memory change feature M.

The first sample program was run as shown below:

***L**
***M A048**
A048 00 **00**
A049 6C **00**
A04A 9C
***G** D9 OA FF FCFC 0004 A042

The main features of MIKBUG are used in running this program. The bold sections indicate the user input, whereas any digit not inderlined was printed as MPU response. In this way A048 and A049 were set to 00 00 as defined by the ORG statement. The G caused the program to run until SW1 was executed. The print out following G results from SW1 and can be interpreted as condition codes (D9), B accumulator (OA), A accumulator (FF), index register (FCFC), program counter (0004) and stack pointer (A042).

The program loaded the A accumulator with 00000001 then complemented this to give 11111110 which was then incremented. The result 11111111, or FF in hexadecimal, is the two's complement of the original number loaded into A.

Thus the operation of the program can be verified, in this case, by noting the contents of accumulator A, shown in the print out, following the G command.

The interrelation between the operating system, the editor and the assembler software has been introduced. Finally the reader is invited to consider the second sample program run shown below:

***L**
***M A048**
*A048 00 **00**
*A049 04 **64**
*A04A 9C
***G** D4 OA OA FCFC 006C A042
*
Did this program run correctly?

HEXADECIMAL CONVERSION

8		7		6		5		4		3		2		1	
Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	268,435,456	1	16,777,216	1	1,048,576	1	65,536	1	4,096	1	256	1	16	1	1
2	536,870,912	2	33,554,432	2	2,097,152	2	131,072	2	8,192	2	512	2	32	2	2
3	805,306,368	3	50,331,648	3	3,145,728	3	196,608	3	12,288	3	768	3	48	3	3
4	1,073,741,824	4	67,108,864	4	4,194,304	4	262,144	4	16,384	4	1,024	4	64	4	4
5	1,342,177,280	5	83,886,080	5	5,242,880	5	327,680	5	20,480	5	1,280	5	80	5	5
6	1,610,612,736	6	100,663,296	6	6,291,456	6	393,216	6	24,576	6	1,536	6	96	6	6
7	1,879,048,192	7	117,440,512	7	7,340,032	7	458,752	7	28,672	7	1,792	7	112	7	7
8	2,147,483,648	8	134,217,728	8	8,388,608	8	524,288	8	32,768	8	2,048	8	128	8	8
9	2,415,919,104	9	150,994,944	9	9,437,184	9	589,824	9	36,864	9	2,304	9	144	9	9
A	2,684,354,560	A	167,772,160	A	10,485,760	A	655,360	A	40,960	A	2,560	A	160	A	10
8	2,952,790,016	8	184,549,376	B	11,534,336	B	720,896	B	45,056	B	2,816	B	176	8	11
C	3,221,225,472	C	201,326,592	C	12,582,912	C	786,432	C	49,152	C	3,072	C	192	C	12
D	3,489,660,928	D	218,103,808	D	13,631,488	D	851,968	D	53,248	D	3,328	D	208	D	13
E	3,758,096,384	E	234,881,024	E	14,680,064	E	917,504	E	57,344	E	3,584	E	224	E	14
F	4,026,531,840	F	251,658,240	F	15,728,640	F	983,040	F	61,440	F	3,840	F	240	F	15
8		7		6		5		4		3		2		1	

HEXADECIMAL TO DECIMAL

1 Locate column of decimal numbers corresponding to left-most digit or letter of hexadecimal select from this column and record number that corresponds to position of hexadecimal digit or letter.
2 Repeat step 1 for next (second from left) position.
3 Repeat step 1 for units (third from left) position.
4 Add numbers selected from table to form decimal number.

DECIMAL TO HEXADECIMAL

1 (A) select from table highest decimal number that is equal to or less than number to be converted.
(B) Record hexadecimal of column containing selected number.
(C) Subtract selected decimal from number to be converted.
2 Using remainder from step 1 (C) repeat all of step 1 to develop second position of hexadecimal (and remainder).
3 Using remainder from step 2 repeat all of step 1 to develop units position of hexadecimal.
4 Combine terms to form hexadecimal number.

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Artificial Intelligence

M. C. Fairhurst of the Computers & Cybernetics Group, University of Kent, gives an introduction to the principles of some very exciting research that's being done there which could lead to a better understanding of the human brain — or a better computer.

ARTIFICIAL INTELLIGENCE — by which we mean the imitation by artificial systems of characteristics which we describe as intelligent when observed in humans — is a field which has attracted an increasingly large amount of research effort in recent years. While nowadays artificial intelligence is generally acknowledged as an academic discipline in its own right, the term is often used interchangeably with other terms such as bionics, robotics, and so on with the result that the layman becomes confused and the purist indignant. Whatever its precise terms of reference, what is clear is that artificial intelligence embraces concepts and theories from many different disciplines including mathematics, cybernetics, computer science, psychology, biology and others. A recent series of articles (ETI May 1978) has given a very comprehensive introduction to some current ideas in robotics while a subsequent article (ETI July 1978) on Brains and Computers introduced readers to the structure of the human brain and therefore the processes and mechanisms which underlie every aspect of human behaviour. It is hoped that this article, in so far as it presents an alternative approach to problems in artificial intelligence, will bring together some basic ideas from each of the two preceding ones.

The most prevalent philosophy for the design of an artificially intelligent system (for example, to provide the "brain" of, say, an industrial robot) is that either a general-purpose digital computer is programmed in such a way as to accomplish the desired task, or that some special-purpose computing system is explicitly designed to achieve the same result. While such a computer program or electronic design does not necessarily preclude the possibility of future self-programming or adaptation of behaviour, the essence of this approach to the design of an intelligent machine is that the "intelligence" is somehow imposed by means of external intervention or manipulation.

This is by no means the only design philosophy which might be adhered to. An alternative approach becomes immediately attractive if it is recognised that certain types of system possess inherent, as opposed to externally-imposed, intelligent characteristics. The problem of constructing an intelligent machine or robot then becomes one of *exploiting* these existing characteristics in a meaningful way rather than one of creating them in the first instance. We shall investigate the implications of pursuing this second approach, and we begin by exploring the nature of inherent intelligence in more detail.

M. C. Fairhurst of the University of Kent, author of this article

Intelligence From Chaos?

Let us look for an example of intelligent behaviour in what at first sight may seem to be an unlikely situation. Figure 1 shows a network made up of interconnected electronic cells, each of which receives and generates binary signals. The operation of a cell may be easily represented by a table such as that of Table I, which lists all possible signal combinations at the input of the cell and the corresponding output signal in each case. Note that the variables Q0, Q1, Q2 ... can each be either 0 or 1. The precise values given to these variables for any element define the *function* of that particular element

Input 1	Output 2	Input 3	Output
0	0	0	Q_0
0	0	1	Q_1
0	1	0	Q_2
0	1	1	Q_3
1	0	0	Q_4
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
1	1	1	Q_1

Table 1: Association between possible sets of inputs and their corresponding outputs.

and determine exactly how the element will operate. For a cell with K inputs there are exactly 22k different functions which could be defined.

Readers familiar with the principles of digital circuit design will recognise that the electronic cells described are examples of logic gates, although here we assume that *any* function may exist and not only the more usually-encountered functions such as AND, OR, NAND etc). As an illustration, Table 2 shows a complete set of possible functions (f0-f15) for a cell with two inputs.

How may we usefully describe the behaviour of the overall network of cells? At any instant in time we list the output signal value of each cell in the network in order. This list, which will consist of each cell in the network in order. This list, which will consist of a string of 0s and 1s, defines the *state* of the network. However, because the elements are interconnected the output of one element may cause the input to another element to change, while this in turn may cause the output of the next cell in the chain to change, and so on. In other words, at successive instants in time the state of the network may change. After a sufficient length of time, of course, because there are a limited number of possible states which exist (000 . . . 00, 000 . . . 01, 000 . . . 10, . . ., 111 . . . 11), a state or a group of states must repeat. We can summarise the network behaviour by drawing a '*State transition diagram*' which shows the changes from one state to the next in the network at successive instants in time. Part of one such state diagram is shown in Figure 2. Note that in order to get a general picture of what is happening in the network it is not necessary to label each individual state at this stage. We can see that in this example the network has just three modes of activity which may be said to be stable – two of these stable modes correspond to the two cycles (repeating groups) of states of three and five states respectively in length. The third corresponds to the single stable state – the state which recurs once reached. It can be seen that all other states, after a sufficient length of time, are ultimately drawn in to one of these stable areas of activity.

The crucial question which we now wish to ask concerns the sort of state transition diagram which we might expect for any particular configuration of elements in the network. For example, suppose that we connect together in a totally random way a number of elements whose functions are selected completely at random from the set of all possible functions. How will this network behave?

Experimental Results

In general terms, our intuition leads us to believe that a system whose specification is random will give rise to disorganised, unstable, possible chaotic, and certainly unintelligent behaviour. For example, let us consider a parallel with the random network situation taken from everyday life. Suppose, for instance, that I arrange my filing cabinet in such a way that I allow some of Mr Jones' letters to be filed under 'S' and others under 'T', wile Mr Brown's letters are put into a file marked 'Mr White' on odd days and a file marked 'Mr Green' on even days. Suppose that I further compound the disorganisation by putting all the P files in the A drawer, and so on. Surely I should not

Input 1	Input 2	Output															
		f_0	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8			f_{11}	f_{12}	f_{13}	f_{14}	f_{15}
0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Table 2: All sixteen possible functions for a cell with two inputs

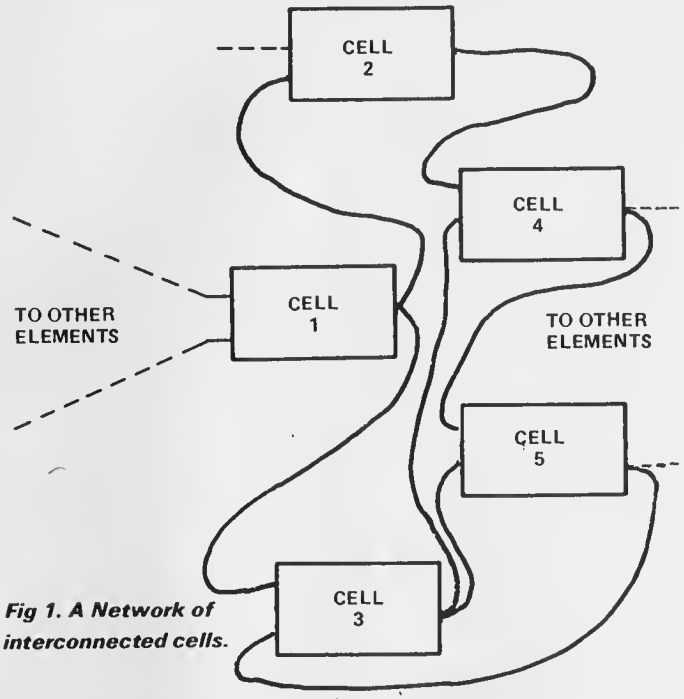


Fig 1. A Network of interconnected cells.

then expect my filing system to be even intelligible, let alone efficient!

To go back to the case of my random network of electronic cells, I should expect the randomness of the situation to give rise to unstable and unintelligible activity in the network, such random behaviour being characterised by the existence in the state diagram of many long strings of meaningless states and cyhcles containing a large number of states.

It is at this point tht a surprising, but most interesting and highly significant observation can be made. In a large number of experiements on many different networks it has been found in practice that rather than the unstable chaos one might expect, a random network exhibits highly stable ar. ordered behaviour, represented by the existence of very few repeating cycles of states each cycle in itself comprising very few states. For example, a random network of 100 electronic cells – with the potential for existing in any one of 2100 states – was found typically to generate only about 10 cycles each consisting of no more than about 10 states. In other words, since after a sufficient length of time the network will be found to exist in one of only relatively few state cycles, we may say that the system has a restricted and manageable number of different modes of activity and is, therefore, stable. This inherent ability of the network to organise its behaviour into one of a well-defined number of modes of activity leads us to attribute to the network a pre-disposition for intelligent behaviour, in just the same way that we might feel inclined to attribute intelligence to our "chaotic" filing system if we opened a drawer to find out, despite our lack of coordination, all the files on "Mr Brown's interview" had ended up together in one place.

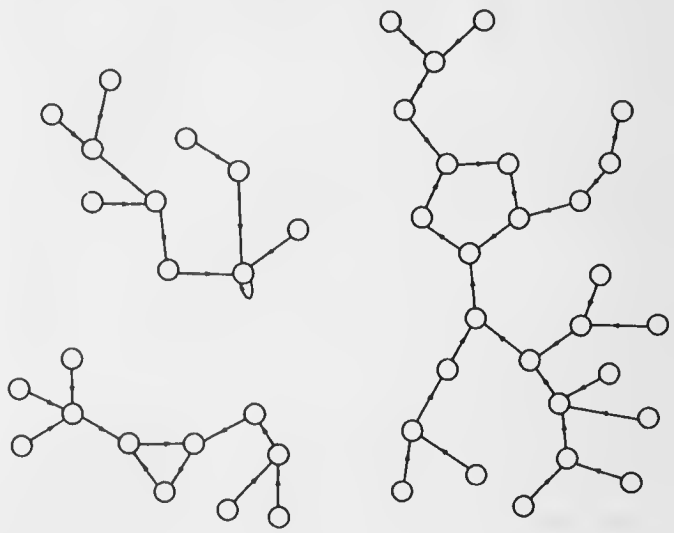
Three further points need to be made clear in the context of intelligence in networks of electronic processing cells. First, we may allow the network to interact with its environment by allowing some of the element input channels to be connected to the external world rather than to other cells. In this way the network can be made to *respond* to some stimulus by following a trajectory of transitions to some state cycle. Second, if we arrange for the element functions to be variable - i.e. we allow them to change if some appropriate signal is received) then the state structure is itself variable, and the network can be made to learn and thus make meaningful associations between external events and its own possible modes of activity. Third, in a practical context – which is of major significance to many readers of this magazine – all the required properties of ther electronic cells which are described above may be realised by utilising the commercially available, easily obtainable and very cheap random access memory device to implement the electronic cells which make up the network.

Although the idea will be pursued later it is worth pointing out at this stage that the overall structure of the electronic system as described is not unlike the structure of the brain. It has two extremely important features in this respect. First, the intelligence of the system is not localised in any specific area, but distributed over the entire network. As a result the system is much less susceptible to localised damage than more conventional electronic systems, in much the same way that our memory traces can often be retained despite severe disruption of the brain's activity. Second, the system processes its data in a *parallel* rather than *serial* mode, (all the cells operate simultaneously) with a consequent ability for high processing speeds.

Intelligence in Action

Let us suppose that we wish to construct a device which will automatically read and identify letters of the alphabet (clearly a task requiring intelligence, whether carried out by a man or a machine). A simple scheme for accomplishing this task is shown in Figure 3. A TV camera is used to sense the image which is then encoded (or "digitised") by means of suitable circuitry into a binary representation, and this coded

Fig 2. Part of a State Transition Diagram.



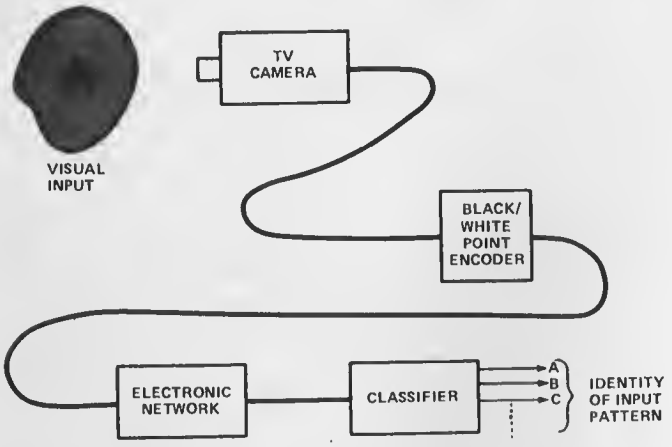


Fig 3. A simple method of recognising visual patterns.

version of the input fed to a network of adaptive electronic cells as described.

We now exploit the natural intelligence of the network by modifying the element functions — in other words we "teach" the network — in such a way that it will respond to examples of a particular pattern class (e.g. the letter "A") by entering a particular state cycle, the equivalent of executing just one of its possible modes of activity. The classifier is then required to identify the cycle entered and hence signal the identity of the pattern which was received at the input.

It is easily seen that the system is making use of the natural stability of the network in so far as the number of states which need be identified is dramatically smaller than the total number of possible input patterns which may occur. It is exactly this property of the network which transforms the problem from one of identifying a potentially very large set of inputs to the much simpler problem of identifying one out of a much smaller number of possible cycles.

Intelligence and Models of the Brain

Of considerable interest in the context of the possible exploitation of the inherent intelligence of cellular electronic networks is the fact that the human brain is itself a cellular structure, whose processing units are biological computing cells called neurons (a description of the properties of neurons is given in "Brains and Computers", ETI July 1978). Although the computational mechanisms of electronic cells and biological neurons are very different, there are nevertheless certain similarities in terms of the respective functions performed. For example, both types of cell operate on signals which are essentially binary in nature — in terms of voltage levels in the electronic case and the generation or non-generation of voltage pulses in the biological case — and both compute a function relating an output signal to the pattern of signals appearing on their input channels at any instant. Structurally at least, therefore, the type of electronic network described above is a closer model of the brainthan is a conventional computer system.

Furtheramore it is possible, in principle at least, to characterise brain activity in terms of a state diagram. Although a complete state diagram of the brain if it could be plotted exactly would contain about 2^{1010} states (since it is estimated that the brain contains about 10^{10} neurons), a *model* of a neural network, which could of course be physically realised using our familiar electronic network structure, can be a very versatile means of characterising and formalising the brain mechanisms which underlie human behaviour.

In such a model, the transitions from one state to the next correspond to "thought processes", while learning is embodied in the fact that the element functions can change in response to information received by the network. It is possible, using this approach, to describe many psychological and physiological functions in terms of state-to-state activity, and processes such as recognition of environmental events, recall of stored information, long-term and short-term memory processes, and a mechanism of speech production are but a selection of functions which may be described and characterised in this way. The benefits likely to be obtained in this area are twofold since, not only can such endeavours lead towards a clearer implicit understanding of brain function itself, but such a characterisation of intelligent behaviour can give insight into the design of intelligent machines for many different purposes and applications.

What of the Future?

An article of this nature cannot hope to indicate all the areas of research currently in progress, nor deal in excessive detail with those topics which are described. Neither is it possible to predict with any degree of confidence likely levels of achievement of future generations of intelligent systems. One thing which is certain, however, is that the search for machines with a capacity for intelligent behaviour will continue and increase. One of the most encouraging features of the approach described here is that it focusses as a unified entity the work of engineers, physicists, mathematicians and even psychologists. It may be that the current trend towards cheaper and more readily available computing facilities and electronic components will provide exactly the right stimulus for even more widespread and interdisciplinary cooperation, and allow significant progress in this area. Indeed, it is this exciting possibility which is perhaps the main justification for the work described here.

Further Reading

Further reading on these and related topics can readily be found by scanning the scientific literature in cybernetics, computer science and digital electronics. To mention just one specific reference cannot do justice to such a wide and challenging field, but "The Metaphorical Brain" by M. A. Arbib offers a very readable and stimulating introduction to the basic aims of cybernetics, emphasising particularly the value of brain research in tackling engineering problems in artificial intelligence.

Phil Cohen visited the author of the above article at the Kent University to find out what the results of the research has been so far.

When I read the above article my immediate impression was: Fine, but does it work? To find out, I paid a visit to the Kent University's electronics lab, to see what they were up to.

While the system described in the above article is still in a fairly early stage of development, a very similar system built on slightly less advanced principles was very much in evidence.

The first thing I was shown was a computer simulation of a 'learning net' in action. The machine was pretending to be a network of cells connected as shown in Fig.5.

To explain its action: It was trying to recognise typewritten characters. Looking at figure 4, the digitised picture information is fed into the array at the top left of the diagram (the pattern shown is a letter "T").

There are several blocks of RAM attached to this array, each organised as 16 x 1 bits. The address lines are fed from different parts of the array, the entire array being covered all in all.

This entire network (i.e. the part of Fig.4 inside the dotted line) is dedicated to recognising one character.

What happens is this: During the 'teaching' mode, the letter to be recognised is fed in to the array. The 'teach enable' and the 'teach data' of the network are held high and a '1' will be fed into the location of each RAM which is indicated by the input pattern.

A variety of other patterns (i.e. other than "T") are then fed into the array and a "0" is fed into the locations indicated by the new patterns.

During the run mode, an 'unknown' pattern is fed in and the network which has been 'taught' to recognise it will produce a lot of "1"s at the RAM outputs.

Now looking at Fig.5, the system will see which network is producing the most "1"s and will output the character that that network (the one with the most "1"s) is trained for. In this way the system can cope with 'noisy' patterns — they will still (hopefully) produce more "1"s in their network than in any other.

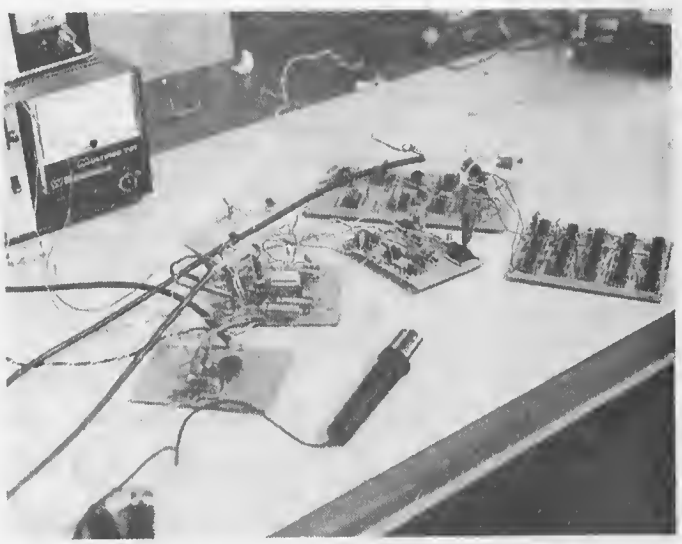
One of the research team gives the apparatus a phonetic example (i.e. sings to it!).

At Kent University they are using the system on data supplied by the GPO. The data consists of arrays derived directly from typewritten material.

The result is a very 'noisy' pattern indeed — a human has to look twice at it! The system seems to manage quite well, though.

An obvious application for this sort of system is in reading typed addresses for the GPO. Another, less obvious, use is in the teaching of handicapped children.

One of the data arrays provided by the GPO.



This sort of scene should be familiar to most ETI readers — an early prototype!

Teaching Aid

The department has developed a stand-alone unit (see. photos) which will give an output which is proportional to hand-eye co-ordination.

What happens is this: Using a light pen, the teacher 'draws' a character (anything from a straight line to a pound sign) on an array of LEDs. These are multiplexed in such a way that the unit can follow the path of the pen.

The LEDs which have been pointed to remain on. In this way, the machine can be 'taught' to recognise the character.

Whenever the pupil 'writes' the same character, the unit will give an output which is related to how close

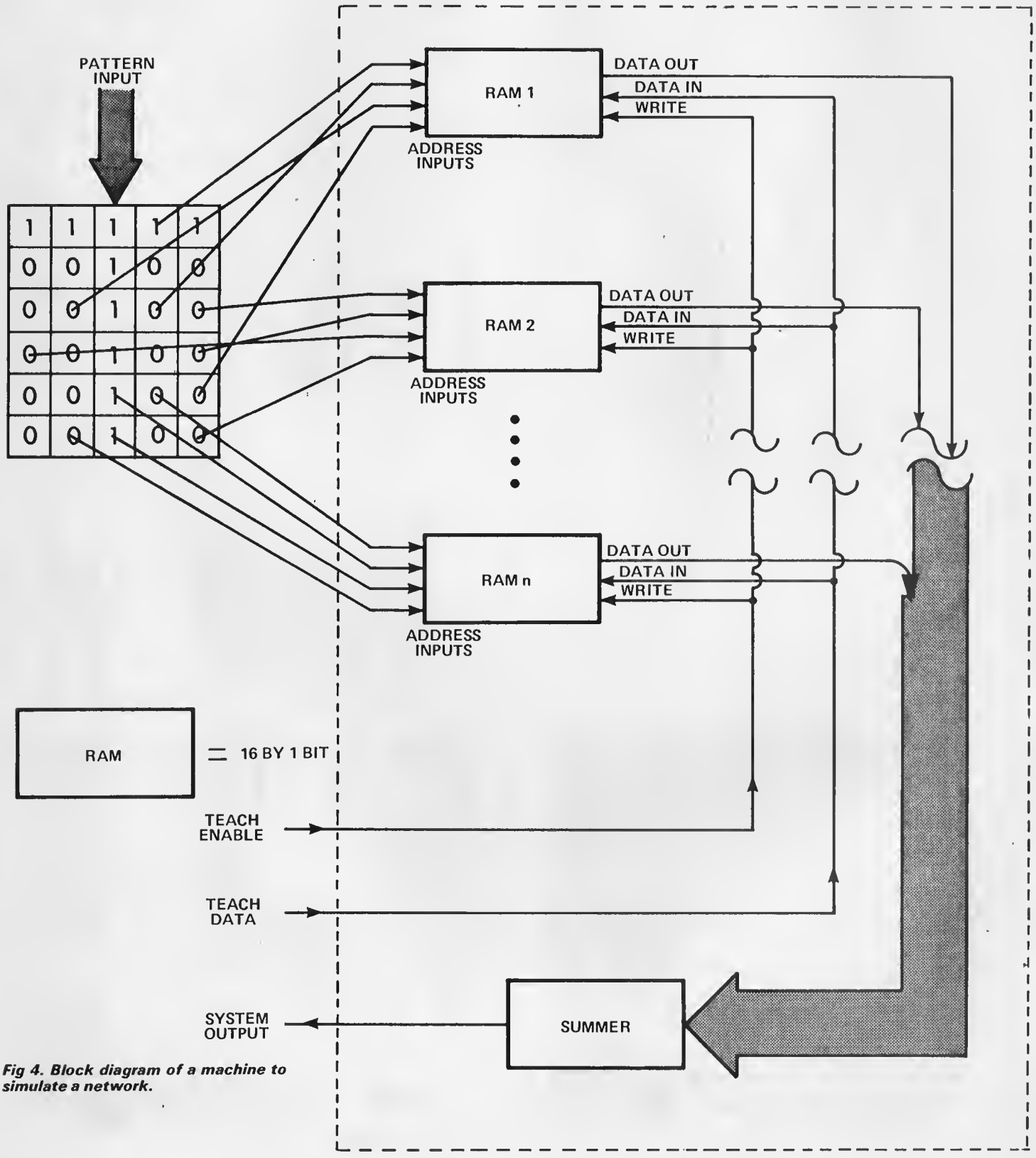


Fig 4. Block diagram of a machine to simulate a network.

the input is to the character it has been 'taught' to recognise. When the correlation passes a pre-set threshold, a lamp lights as a reward.

The advantages of the unit over conventional methods are:

A) It means that one teacher can teach several pupils at a time.

B) The 'threshold' of the unit can be increased slowly as the pupil progresses.

C) Preliminary trials have shown that the unit is successful because the kids enjoy using it!

The Future

There is also research going on into using a similar system to recognise sounds rather than visual patterns. In this respect the system offers several advantages over existing methods — It uses easily

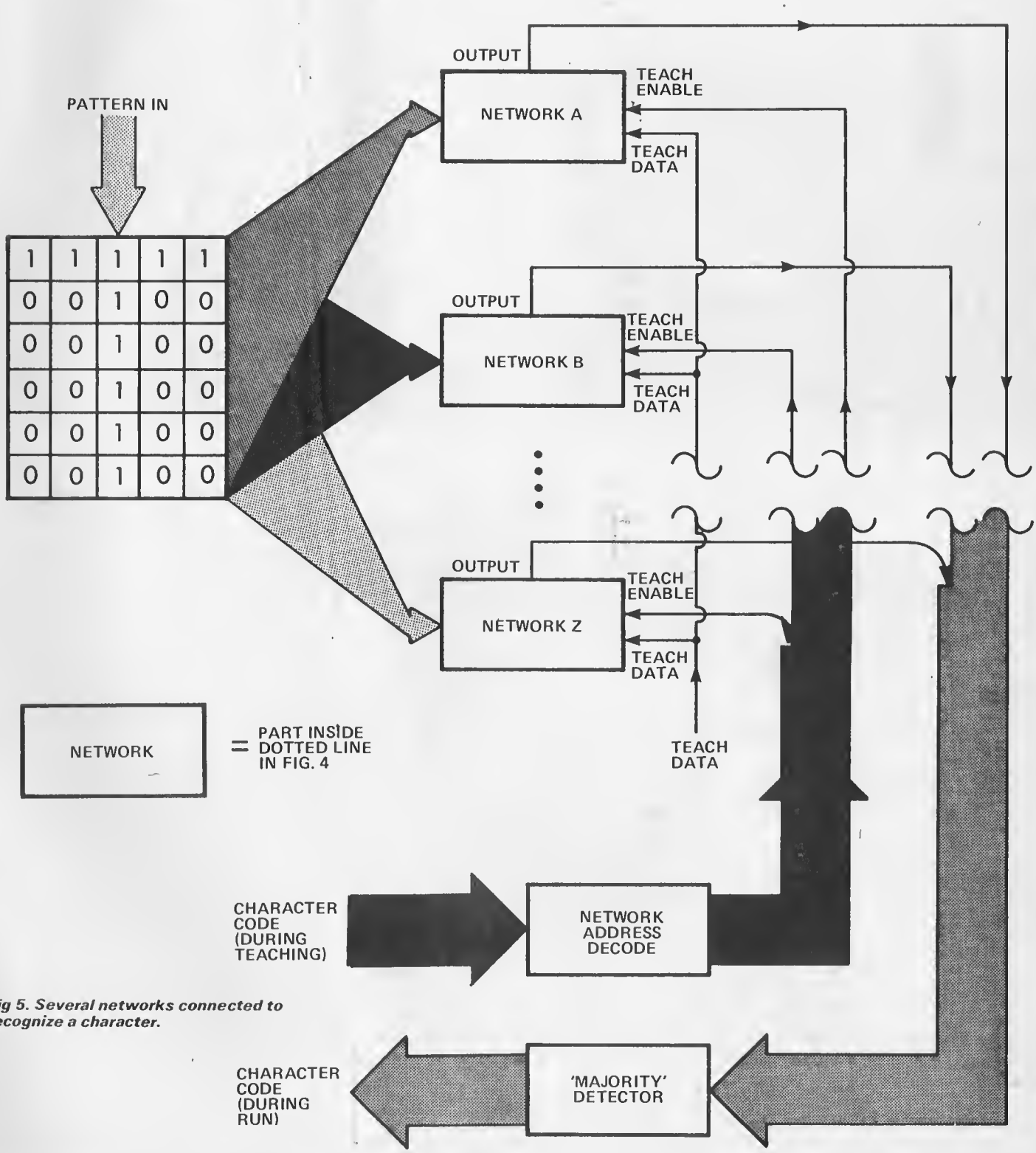


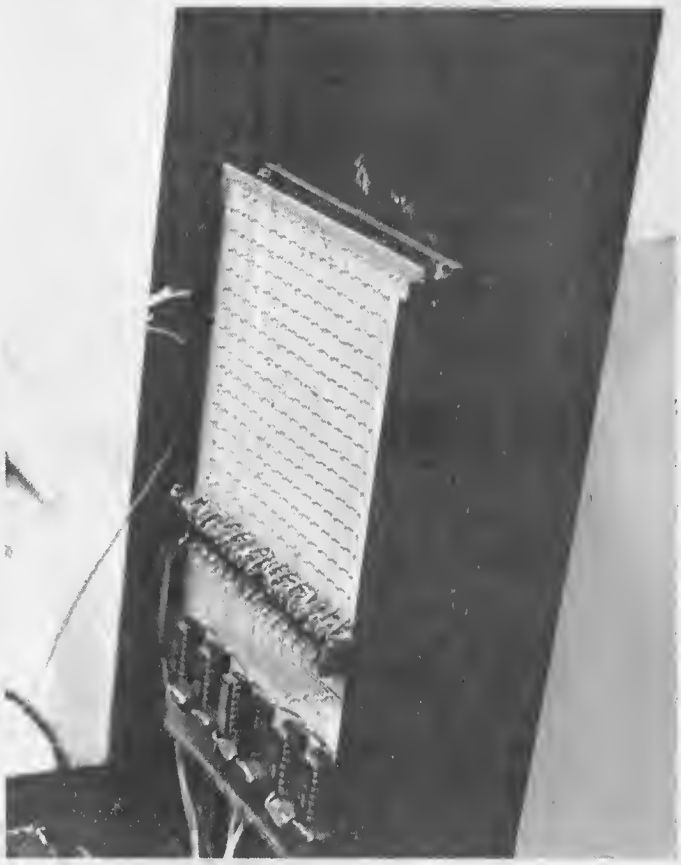
Fig 5. Several networks connected to recognize a character.

available RAM and a minimum of input 'pre-conditioning' circuitry (other similar systems use only a high-pass filter and a zero-crossing detector).

The tremendous advantage of this sort of character recognition over other systems is that it is cheap — the RAM is commercially available at a very low cost per bit already.

There is absolutely no reason why, given the time, trouble, and ingenuity (and RAM), an amateur shouldn't be able to build a system similiar to the one in Fig.4 (or even Fig.5). We would, of course, be very interested to hear of anyone who has any success.

The machine in action — the light pen is being used to 'teach' it a character.



The underside of the LED array.

Letters

Dear Sir,

The article on shopping in the United States in "Microfile" Computing Today; November 1978, (Vol 7, No 11) overlooked the payment of Customs Duty and Value Added Tax. Most goods brought into this country from outside the EEC are liable to Customs Duty and Value Added Tax. This includes private importations of articles by post. Information concerning postal importation procedure is set out in more detail in Notice 143 obtainable from the Secretary HM Customs and Excise, Kent House, Upper Ground, London SE1 9PS, but a brief summary follows.

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— Cassette — tape recorder coupling

— Originate and answer modes

— Half-duplex et full-duplex operation
— Line frequency detection

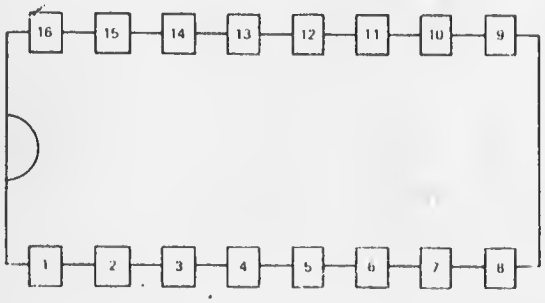
— Inputs and outputs compatible with C-MOS 4000 B serie

— Crystal oscillator

PINOUTS

1 CRT display input
2 Tape recorder enable input
3 Originate and answer mode
4 Half-full duplex operation input
5 Local operation input
6 Line modulator output
7 Line demodulator input
8 Vss
9 Line carrier detection input
10 Tape recorder demodulator input
11 N/C
12 Crystal Oscillator input
13 Crystal Oscillator output
14 Tape recorder modulator output
15 CRT display output
16 V_{dd}

Top view



Pin functions — **Pins** / *Broches*

CRT display input — **1**
This signal is a binary data input that is delivered in serial format from the CRT display to the modulators of the modem (line modulator or tape-recorder modulator). In this two cases this signal will be modulated using FSK techniques.

Cassette-tape recorder enable — **2**
When a logic "1" the cassette-tape recorder input is enabled into the modem.

Originate and answer modes — **3**
The mode input selects the pair of transmitting and receiving frequencies used during modulation and demodulation. When at logic "1", the modem operates in the answer mode. When at logic "0", the modem operates in the originate mode.

Local Operation — **5**
When at logic "1" both the line modulator output and the line demodulator input are inhibited. Then, the modem operates only with the CRT display and the cassette-tape recorder.

Line modulator output — **6**
The output line modulator is a sine wave produced by a digital-analogic synthesizer. It allows the realization of four following frequencies: 980, 1180, 1650, 1850 Hz.

Line demodulator input — **7**
The line demodulator input is the FSK signal; that is a square wave resulting from external filter and limiter.

Line carrier detection — **9**
A "1" state on this output indicates that the FSK signal from the telephone line is received and demodulated in the modem. When this output goes to a logic "0", the FSK signal is absent.

Tape-recorder demodulator input **10**
This input signal receives a square wave from the tape-recorder (1200 or 2400 hertz).

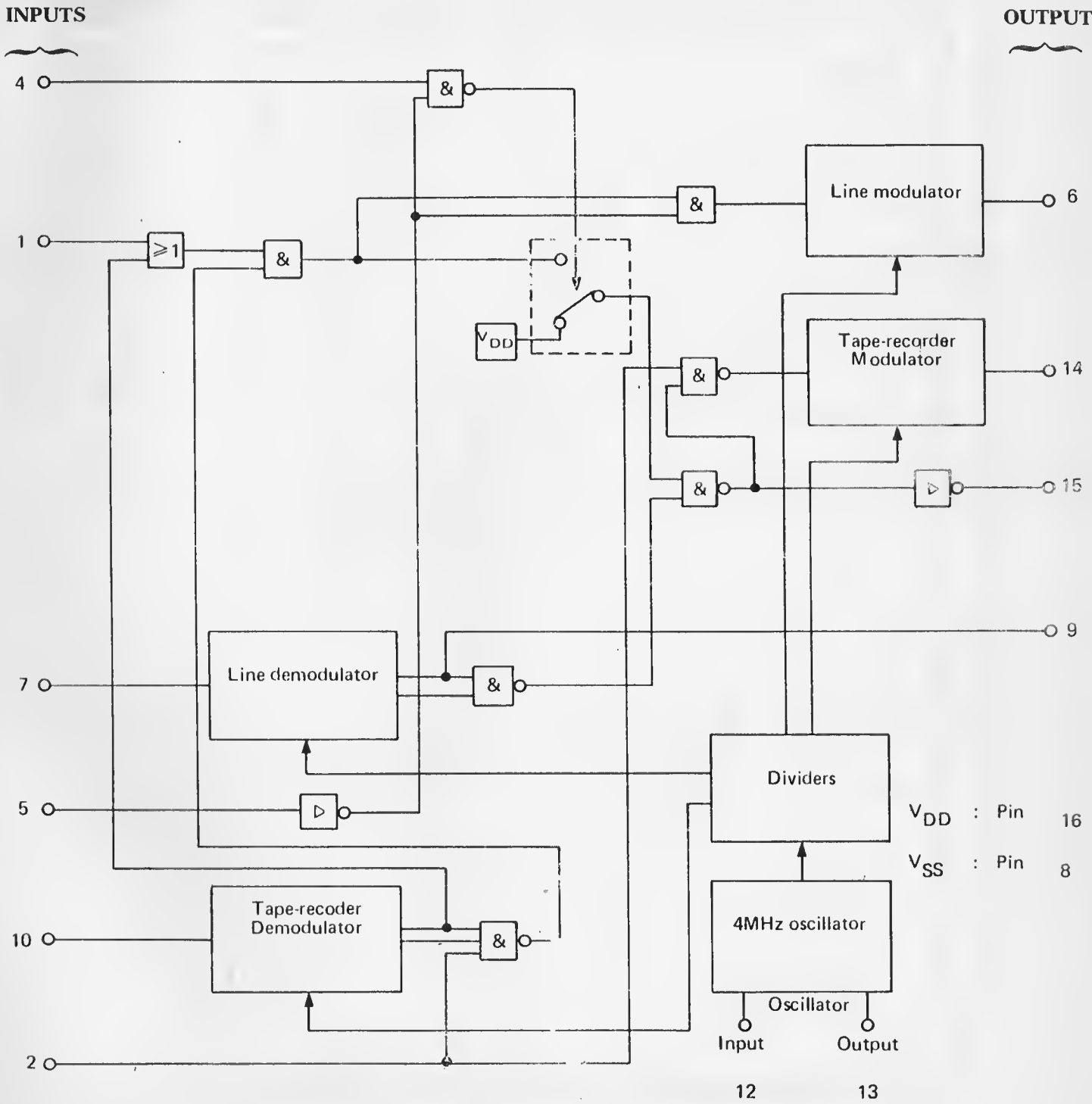
Crystal oscillator input, output **12-13**
A standard 3.93216 MHz crystal is required to utilize the on chip oscillator.

Tape-recorder modulator output **14**
This output delivers a square wave (1200 or 2400 hertz per second) to the tape-recorder.

CRT display output **15**
This output sends out the binary data to the CRT display.

The DF F96501 is manufactured by Thomson-CSF Components, Ringway House, Bell Road, Daweshill, Basingstoke, RG 24 0QG and should be available soon.

Block diagram of the SF.F 96501



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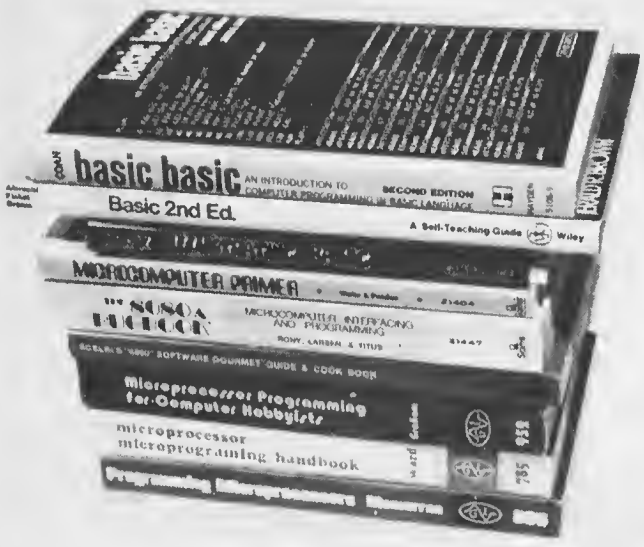

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Bally Arcade: More Than Fun

The Arcade is part of a new wave of machines. But who's it for? Graham M. Wideman and Mark J. Czevwinski report.

IT HAS BEEN several months since we have looked at the "popular" computer scene and as expected the aim of some of the new products has moved still further toward the "consumer." In other words, companies are looking for bigger and bigger markets, to people who have (initially) less and less knowledge or experience of computers.

It was a couple of months after our February review that the Commodore PET was finally approved and offered for sale in Canada. Already there are a number of active and enthusiastic PET user clubs. The accessories and adjuncts also are now coming available.

Meanwhile, at the Radio Shack camp, the TRS-80 (basic model reviewed in April) has also been available for some time, and is on display at numerous Radio Shack outlets. This machine can be had with or without the much improved BASIC language version known as "Level II". An extensive collection of accessories present and future strengthen Radio Shack's computer line.

Upon reviewing these two machines we were aware that they were a new step in microprocessor based computers, in that they required no hardware knowledge and allowed the owner to start with nothing more than the willingness to learn about BASIC. A big part of this was the fact that these machines have BASIC language built in (in ROM) so there's no time consuming loading of the BASIC interpreter off cassette, nor the agony and heartbreak of BASIC bomb-out due to a bug in your program. For anyone familiar with the earlier hobbyist (fanatic!) computers, this is real luxury!

The general public is at least becoming aware of these small computers, as the PET may be seen at several department stores, and the TRS-80 receives national TV advertising publicity.

But will this attract the big market? How far can you go towards the consumer to get him to buy a computer? With these questions in mind we were very interested to see the Bally Arcade. ▶

Fig 1. Calculator style keyboard is labelled with calculator functions. Arrow scrols display.

THE ARCADE ITSELF

The least you can buy is the Bally Arcade "box", which on the outside has a calculator style (and labelled) keyboard (Fig. 1), a slot for a Bally cassette (Fig. 3, more on this below), and on top a rack for storing such cassettes. On the back are a number of sockets for plug in accessories, included with the unit are two hand controls. From the back of the unit also extend the cables for power cord and output to your colour TV's antenna input.

So what can you do with this unit. It may sound initially like a disappointment at $599, but this unit as it enables you to play 3 video games and to use the machine as a four function calculator with TV display. We have to say however that they are pretty amusing, interesting and skill testing games.

We spent hours with our favourite, "Gunfight," where two six-shooter equipped cowboys march onto the screen to the tune of "Home on the Range", and then each player with hand control walks his man around the screen shooting at each other. (Realistic gun sounds). Various obstacles appear in subsequent shootouts, cacti, trees and a wagon. The graphics and action are quite good, with varying gun angle, and bits of cactus and tree which can be shot off. More tunes are played if one cowboy hits the other, (who falls dead on the ground).

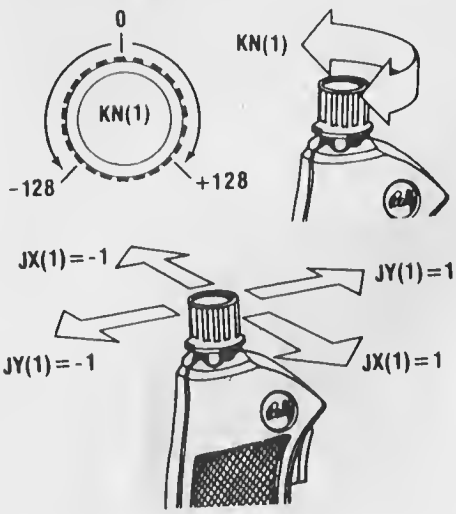
This and the other games, apart from being entertaining, demonstrate the machine's ability to produce four colour graphics, and play tunes, both of a nature very sophisticated in comparison to simple video games. One of the games in fact allows you to change (using the keyboard) each of the four colours to others.

The calculator feature was not very impressive, being a simple four function model (10 memories, floating point). It does allow you to see the preceding steps (about 100) of your calculation like a printing calculator, which is good if you don't need the actual paper. One distressing point was that there is no minus sign to indicate a negative number, it simply turns from black to red, which is not so useful if you have a black and white TV. However, it does firmly tell the user that this is not just a video game.

THE "CASSETTE"

So fare we haven't stretched the capability of the micro-processor yet, so let's look at an as yet unused feature, the "cassette". It is not an audio tape cassette, but a similar looking package, which contains up to 8K of ROM (permanent memory), and has a row of

Fig 2. One of the two hand controls supplied with the Arcade. Sockets on the machine accommodate two more.



contacts along the edge which connect to those in the cassette slot. (Fig 3). This is quite a clever concept in that the public is already familiar with audio cassettes of similar shape, and does not have to be introduced to a new plugging idea.

A wide range of games cassettes are or will be available at $34.95, with such appetite whetting names as "Desert Fox", "Space Race", and "Red Baron" (represented on our cover), "Backgammon" and some "educational" games like "Spell'n'Score" and "Crosswords".

However, the most interesting cassette is the one that allows you to program the machine in BASIC language, price $99.95.

BALLY BASIC

This is not a language for the serious programmer, since in the way of numbers it will handle integers only, up to about 33,000. However, it does include the familiar set of BASIC functions which enable the user to become acquainted with programming. The most important aspect here is motivation, and the user will find this, as Bally has made manipulation of the inputs, sound and graphics quite easy.

Hence the new programmer can quickly be designing his own games, "video art", accompanying tunes and some graphing etc. The BASIC instruction book is quite comprehensive and gentle in its explanations, and has numerous examples and entertaining programs.

The programmer has available 1800 "memory locations", 26 integer variables (A-Z) and one array called @. While there is no real character or string variable one can fudge it. An attempt to store a character (enclosed in quotes) in the @ array results in its ASCII code value being stored. Hence @(1), "1" results in @(1) equalling 49. To recover the letter however you would have to write a program with lots of IF statements to decipher the section of the @ array which you know is supposed to be characters.

BASIC IN USE

The BASIC kit includes an "overlay" which fits over the keyboard to tell you its new functions. Just as a typewriter has two "cases", the keyboard now has five cases, with the bottom row used when selecting one of four "upper" cases. Referring to Fig. 5, the numbers (and similarly positioned functions) may be obtained by simply pressing that key. The functions such as FOR, TO, NEXT, GO TO etc are obtained by first pressing "WORDS" then the appropriate key. The letters and characters in the white boxes above each key are actually coloured, and are obtained by first pressing the same coloured button at the bottom next to the "WORDS" key.

Needless to say, this keyboard is cheaper than a full keyboard, and can be faster, in that only 2 keystrokes are required to enter something like "LINE" or "STEP" and so on, but it can get confusing. You can of course always see what you've entered since it's on the screen, (and when you push one of those other four buttons the screen changes to that colour!). If you make a mistake you can "backspace" over characters in the same line, but to go back and change a line already entered you'll have to retype the line.

There are two other buttons on the Bally, RESET and EJECT (cassette). You don't want to hit either of these after you've entered a program, otherwise agony! We dound the EJECT button much too easy to accidently brush, perhaps Bally could supply a piece of cardboard to stick over it! ▶

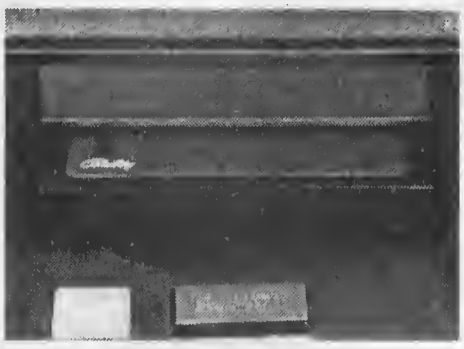


Fig 3. Just stick it in and pop it down (left).

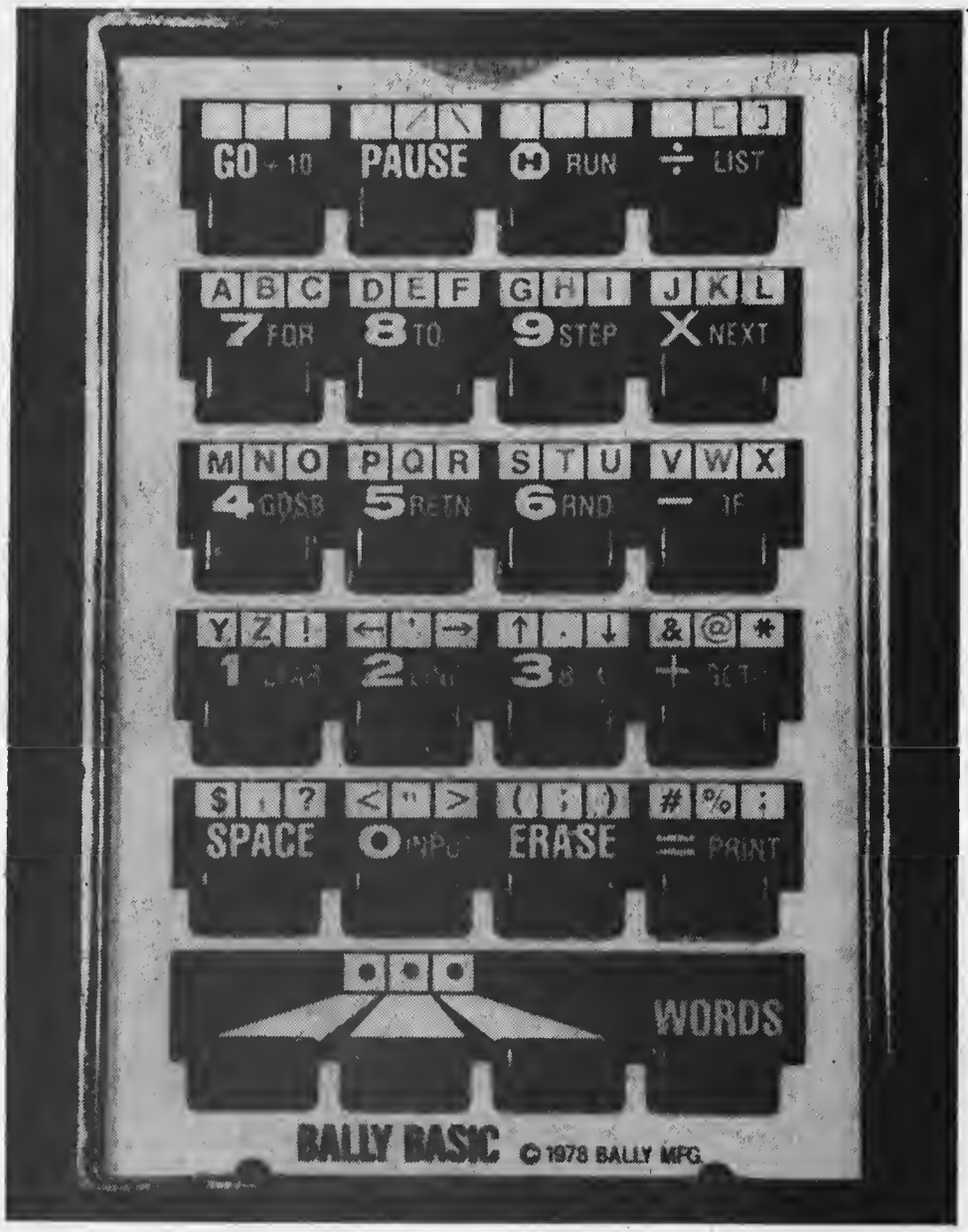


Fig 5. BASIC overlay on keyboard shows functions and instructions available.

GRAPHICS

The very best part of this BASIC is the easy interfacing, best described by explaining some of the "machine variables". To input from a hand control, simply look at the values of JX, JY, TR or KN, which correspond to the joystick, trigger, knob positions. To pick the colours for the screen you set BC and FC from 1 to 256 to select the "background" and "foreground" colours. (Only two colours available when using BASIC). To draw on the screen you can write a dot, line or box using only one statement to specify its position, size, and colour. (Fig. 6)

While this is quite a respectable capability, it won't allow you to program games as complex graphically as the Bally has built in, due to speed and memory constraints.

SOUND

As each character is printed on the screen a note plays from the TV's speaker. The note varies with each character, may be raised or lowered by an octave using the multiply and divide signs, and made sharp or flat with the plus and minus signs. (Fig. 7) A simple PRINT statement with a series of numbers and

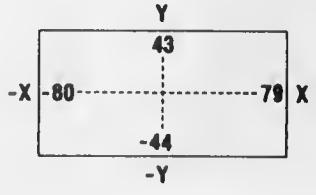


Fig 6. For graphics purposes the screen is divided into 88 x 160 squares.

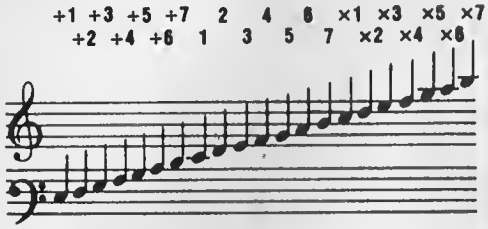


Fig 7 (above). The numbers corresponding to the musical scale.

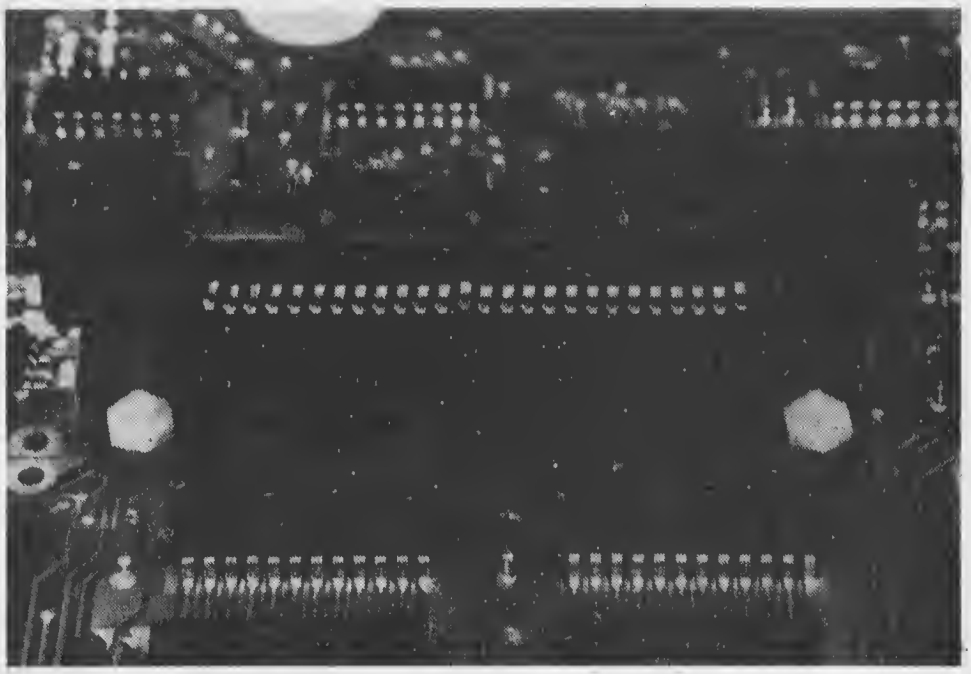


Fig 9 (right). Cassette socket attached directly to the board.

signs plays an interesting tune. "Rests" are available, and the note speed can be varied using the machine variable NT. NT however also varies the print-out speed, so don't set it too slow while you're programming or you may never finish. Its initial value is quite satisfactory.

Now, to a musician this doesn't sound like a lot of capability (it's more than enough for punk rock). It's surprising how good it does sound, though, and the simplicity contributes to learning about sound and music. But please Bally, give us some nice satisfying gun and explosion sounds!

AUDIO CASSETTE

In order to store programs for long periods of time the user can purchase the BASIC audio interface to allow recording and retrieving with an ordinary cassette recorder.

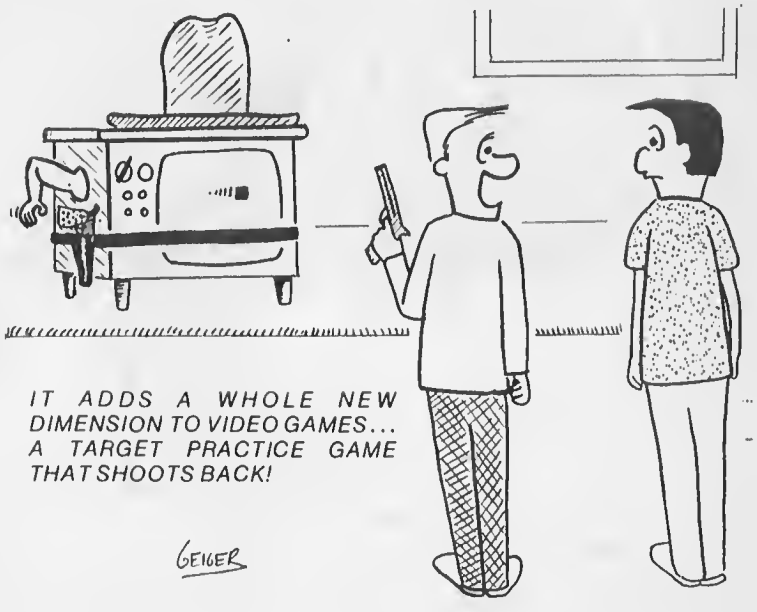
HARDWARE

We took our review unit apart (carefully!) and here's what we found inside. Heart of the Arcade is the powerful Zilog Z80 microprocessor (actually Mostek's version: 3880). This is accompanied by 8K of ROM which stores the games, and 4K of RAM which mostly acts as the screen memory. Although the cassette pack is reportedly capable of containing 8K of additional ROM, ours appeared to have only 4K (Fig 10). When the BASIC cassette is in use, half of the 4K RAM is used for program storage, which means that only half as much screen memory is available explaining why only two colours are available to the programmer.

The various support chips are described in Fig. 8. Of special note is the "music processor" chip, which generates the musical tones of the chromatic scale from a single master oscillator.

As shown in Fig. 2 the hand controller gives 3 types of control: trigger, rotary, and "joystick". The trigger is simply a switch; the rotary control is a potentiometer; and the joystick uses four switch contacts, one each for 0, 90, 180, and 270 degrees, and pairs of ▶

Fig 10. BASIC cassette exposed.



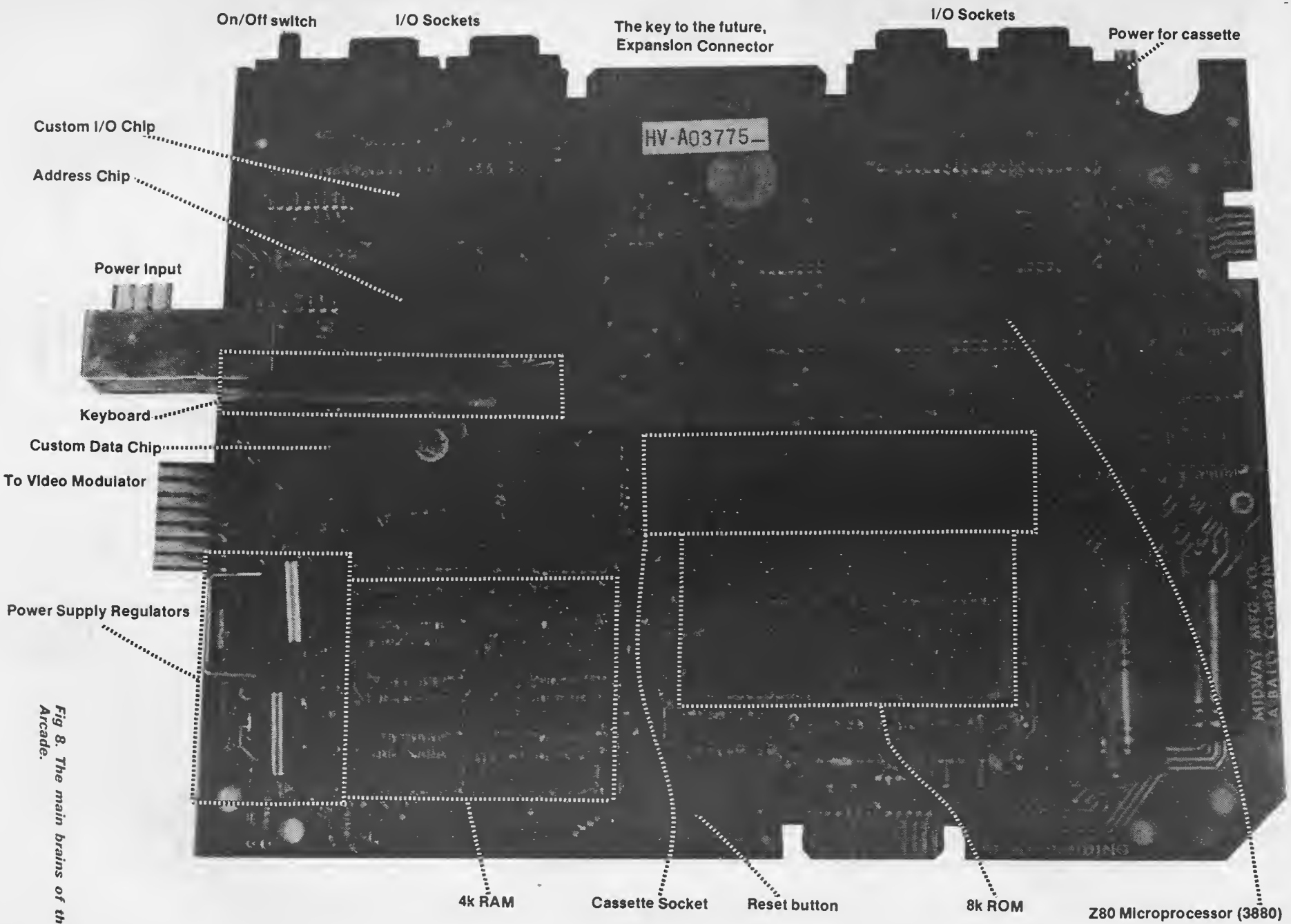


Fig 8. The main brains of the Arcade.

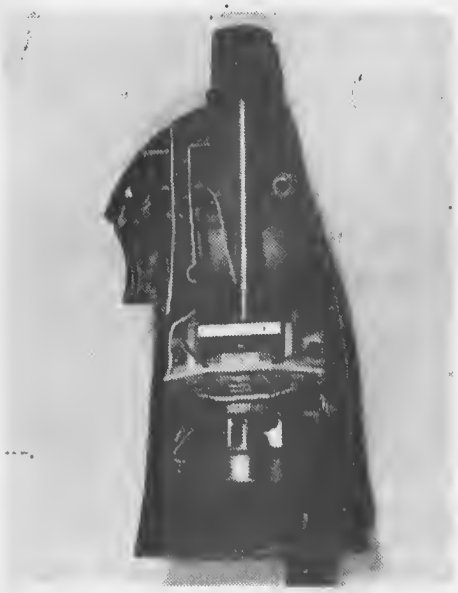


Fig 11. Open hand control shows trigger switch, pot and four way joystick switch module.

those contacts used for the intermediate angles 45, 135, 225 and 315 degrees. We found that a little surgery with pliers was required to get.all the intermediate angles to work properly, but this was probably due to the hard use that the demo unit had received. This is not a high quality precision control by any means, but it certainly works, and hardware enthusiasts will easily be able to use their own switches and pots for other input applications. (Fig. 11).

WHAT'S COMING

What's available so far appears to be only the iceberg tip. The first upgrade will be a proper keyboard box, which will reportedly include an additonal Z80, more RAM, and ROM containing a "serious" BASIC version, Interface for two independent screens and IEEE 488 bus is also being talked about. This is apparently to be introduced in January 79. Also coming are a printer, telephone interface, light pen and floppy disk. Do these sound like add-ons for a video game?

It's pretty obvious that the Bally Arcade is in a new class of product, and will be the most "vertically" extensive product line we have seen so far. The machine has the capability to endear itself to all ages and familiarity-with-computer levels. Once the person is interested they will feel the desire to expand the system and not be afraid to dabble in programming, with the basic BASIC. After some confidence has been obtained with the concept of programming, the user might be encouraged to move up again to the keyboard expander box and advanced BASIC. This is a much more "expand-as-you-learn" approach than the kind of expandability of early home computers, where you had to be pretty knowledgeable to start, and expand as boards became available.

In fact, a learning experienced is that the Arcade is all about, not just in programming, but it is an intriguing exercise in music composition (albeit quite simple), and in colour graphics it provides a no mess, no manual skill artistic tool.

WHERE

The Bally Arcade should start to appear in October 78. It is distributed by Paragon Enterprises, through Zenith Radio's dealer network and also through large department stores. Calculator shops may also be interested, Marketron is already planning to handle the product.

COMPETITION

If this market is going to be big, you can be sure that Bally aren't the only people who thought of getting into it. We have sketchy details of two other possibly similar products being announced in the US (where the Bally Arcade sells for $300). Magnavox has its "Odyssey 2", which has a full touch keyboard and two joysticks, and a plug in cartridge system. It does not appear to have programming capabilities however. Meanwhile, there's a home computer from Interact, again with full keyboard, colour display output, but this time with an audio cassette unit built in; US $499. Finally, Atari is rumoured to have something in the works. Even if it wasn't rumoured you can bet they have.

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Softspot

Production of graphics via a system's BASIC interpreter results in problems due to the inherent slowness of such software. Machine code subroutines are a way to overcome this drawback. Here Mike Hughes has written such a program for the Triton.

Although it is quite easy to use the VDU function within TRITON'S BASIC to produce moving graphics on the display screen you are limited to the speed with which movements can be made. This is due to the inefficiency of an interpreter program. Much better use of TRITON'S memory mapped VDU can be made with programs written in machine code.

This one gives a picture of a simple railway engine followed by a couple of trucks which move across the screen from right to left. As they leave the screen on the left they re-enter again from the right but one line up the screen. The process continues until the train reaches the left-hand side of the fifth line from the top of the screen and then the program repeats itself.

Enter the program starting at address 1600H but when you run it you should start at 1602H. The reason for this is that locations 1600 and 1601 contain the necessary end of file address to allow you to run the program out to tape after you have keyed it in once.

1600		DATA		AE	End of file address (used by
1601		—		16	tape I/O)
1602	START	CALL	CLRSCN	CD	Clear screen; reset cursor
1603		—		34	
1604		—		01	
1605		LXI H	LNTBL	21	Load start of line character position
1606		—		A8	index table
1607		—		16	
1608		MVI M	60H	36	Starting low order address in VDU
1609		—		60	for first character of first line
160A		INX H		23	Increment table pointer
160B		MVI M	13H	36	Starting high address in VDU for
160C		—		13	first line character
160D		INX H		23	Increment table pointer
160E		MVI M	AOH	36	Starting low address in VDU for
160F		—		A0	second line character
1610		INX H		23	Increment table pointer
1611		MVI M	13H	36	Starting high address in VDU for
1612		—		13	second line character
1613		INX H		23	Infrement table pointer
1614		MVI M	EOH	36	Starting low address for VDU for
1615		—		E0	third line character
1616		INX H		23	Increment table pointer
1617		MVI M	13H	36	Starting high address in VDU for
1618		—		13	third line character
1619	MOV1	LXI D	LNEI	11	Point DE to start of first line
161A		—		5D	graphics data table
161B		—		16	
161C		LHLD	LNTBL	2A	Load HL with first character address
161D		—		A8	in first line of VDU (obtained
161E				16	from table)
161F		DCX H		2B	Decrement VDU character pointer
1620		MOV A, H		7C	Check if high order address points
1621		CPI	10H	FE	to fourth line on screen
1622		—		I0	
1623		JZ	START	CA	If it does; start again
1624		—		02	

```
1625            —               16
1626            SHLD    LNTBL   22      Store fresh start of first line
1627            —               A8        in table
1628            —               16
1629            CALL    MVLNE   CD      Move graphics data to VDU
162A            —               52
162B            —               16
162C    MOV2    LXI D   LNE2    11      Point DE to start of second line
162D            —               76        graphics data table
162E            —               16
162F            LHLD    LNTBL+2 2A      Load HL with first character address
1630            —               AA        in second line of VDU
1631            —               16
1632            DCX H           2B      Decrement VDU character pointer
1633            SHLD    LNTBL+2 22      Store fresh start of second line
1634            —               AA        in table
1635            —               16
1636            CALL    MVLNE   CD      Move graphics data to VDU
1637            —               52
1638            —               16
1639    MOV3    LXI D   LNE3    11      Point DE to start of third line
163A            —               8F        graphics data table
163B            —               16
163C            LHLD    LNTBL+4 2A      Load HL with first character address
163D            —               AC        in third line of VDU
163E            —               16
163F            DCX H           2B      Decrement VDU character pointer
1640            SHLD    LNTBL+4 22      Store fresh start of third line
1641            —               AC        in table
1642            —               16
1643            CALL    MVLNE   CD      Move graphics data to VDU
1644            —               52
1645            —               16
1646    DLY     LXI B   2000H   01      Load BC with time delay byte 2000
1647            —               00        (these two bytes may be altered
1648            —               20        by the user)
1649            DCX B           0B      Decrement BC
164A            MOV A, C        79      Move contents oc C to accumulator
164B            ORA B           B0      OR B with contents of accumulator
164C            JNZ     DLY+3   C2      If not zero; keep decrementing
164D            —               49
164E            —               16
164F            JMP     MOV1    C3      Repeat complete move cycle
1650            —               19
1651            —               16
1652    MVLNE   MVI B   19H     06      Set B to number of characters in a line which have
1653            —               19      to be moved
1654            LDAX D          1A      Get character from data table
1655            MOV M, A        77      Store it in VDU memory
1656            INX D           13      Increment table pointer
1657            INX H           23      Increment VDU memory pointer
1658            DCR B           05      Decrement character counter
1659            RZ              C8      Return if zero
165A            JMP     MVLME+2 C3      Otherwise keep transferring data
165B            —               54
165C            —               16
165D    LNE1    DATA    SPACE   20      Data for first line
165E                    SPACE   20
165F                    GRAPHIC 7A
1660                    SPACE   20
1661                    SPACE   20
1662                    SPACE   20
1663                    GRAPHIC 7A
```

1664			GRAPHIC	19	
1665			SPACE	20	
1666			SPACE	20	
1667			T	54	
1668			R	52	
1669			I	49	
166A			T	54	
166B			O	4F	
166C			N	4E	
166D			SPACE	20	
166E			SPACE	20	
166F			T	54	
1670			R	52	
1671			I	49	
1672			T	54	
1673			O	4F	
1674			N	4E	
1675			SPACE	20	
1676	LNE2	DATA	GRAPHIC	15	Data for second line
1677			GRAPHIC	7A	
1678			GRAPHIC	7A	
1679			GRAPHIC	7A	
167A			GRAPHIC	7A	
167B			GRAPHIC	7A	
167C			GRAPHIC	7A	
167D			GRAPHIC	7A	
167E			GRAPHIC	73	
167F			GRAPHIC	73	
1680			GRAPHIC	7A	
1681			GRAPHIC	7A	
1682			GRAPHIC	7A	
1683			GRAPHIC	7A	
1684			GRAPHIC	7A	
1685			GRAPHIC	7A	
1686			GRAPHIC	73	
1687			GRAPHIC	73	
1688			GRAPHIC	7A	
1689			GRAPHIC	7A	
168A			GRAPHIC	7A	
168B			GRAPHIC	7A	
168C			GRAPHIC	7A	
168D			GRAPHIC	7A	
168E			SPACE	20	
168F	LNE3	DATA	SPACE	20	Data for third line
1690			O	4F	
1691			GRAPHIC	73	
1692			O	4F	
1693			GRAPHIC	73	
1694			O	4F	
1695			GRAPHIC	73	
1696			O	4F	
1697			SPACE	20	
1698			SPACE	20	
1699			SPACE	20	
169A			O	4F	
169B			SPACE	20	
169C			SPACE	20	
169D			O	4F	
169E			SPACE	20	
169F			SPACE	20	
16A0			SPACE	20	
16A1			SPACE	20	
16A2			O	4F	

```
16A3                    SPACE   20
16A4                    SPACE   20
16A5                    O       4F
16A6                    SPACE   20
16A7                    SPACE   20
16A8    LNTBL   TABLE
```

Start of table containing VDU's initial character positions

Note that the table of data between 165D and 16A7 contains the hexadecimal codes for alpha and graphic characters which make up the picture. The picture is contained within three lines. There are twenty-five characters making up each line of the picture and the last one in each case is a SPACE (Hex code 20). Provided you work within this 25 character/3 line format you can substitute codes for your own graphics but you MUST finish each group of 25 with a space code otherwise you will leave a trail behind the moving picture!

As variants you can alter the speed of movement by changing the timing byte in locations 1647 and 1648 (make these 00 to 10 respectively to double the speed). You can also change the jump instruction after location 1623 so that the screen is not cleared after a complete cycle. To do this enter 05 and 16 in locations 1624 and 1625 respectively.

Using the logic of this demonstration as an example you should be able to devise moving pictures of your own.

KEEPING TRACK OF VDU MEMORY MAPPING

The TRITON has a special 1024 byte memory which is used by the Thompson CFS Chip for the screen display. When using TINY BASIC, data bytes can be written into this memory using the VDU command.

Unfortunately, the memory is a write only memory and once written to, it is not possible to access the information again.

When programming, the programmer sometimes requires to keep track of which bytes of the VDU memory have been used. To do this using the array @ would require 1024 elements (each of 2 bytes). Even if the characters were packed two per element, 1024 bytes of array would be used.

A much better way to keep track of which bytes of VDU memory have been used is to use a bit map. To do this in TINY BASIC we make use of the array @ and use 15 bits of each element. Therefore only 69 elements of the array are used to map all 1024 bytes.

At the start of the programme it is necessary to zero the bit map

```
10 FOR I=O TO 68

20 @ (I) = O

30 NEXT I
```

A subroutine is then used to test if the required byte has been used

```
100 X = N

110 GOSUB 500

120 IF Y = 1 PRINT 'BYTE USED'

130 IF Y = O VDU N, 122
```


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Among the programs written to run on the Nascom–1 and available now are:

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N is the number of byte of screen memory to be tested. GOSUB 500 executes the subroutine which tests if the byte has been used

Y is set to 1 if the byte has already been used and 0 if not. The bytes position in the bit map is set on during the routine for future subroutine calls.

The bit testing and setting routine is as follows:

```
500  Y = o
510  A = X/15
520  B = X-A*15+1
530  C = @(A)
540  d = 16384
550  FOR E = 1 TO 15
560  IF C < D GOTO 590
570  IF E = B GOTO 640
580  C = C — D
590  IF E = B GOTO 620
600  D = D/2
610  NEXT E
620  @(A) = @(A) + D
630  RETURN
640  Y = I
650  RETURN
```

The routine first takes the memory index X and splits it tinto the element index and bit number. The contents of the appropriate element is then extracted and the process of testing if the appropriate bit is on is started. The routine is complicated by the fact that other higher bits may be on in the element and it is not possible to test just a specific bit.

Therefore the routine starts with the highest possible bit position and tests if this is on. If not on, the routine checks if this was the required bit. If it was, it is turned on in the array and the routine returns to the caller indicating the bit was off when tested.

If the tested bit is off but it is not the required bit, the routine selects the next highest bit and starts the testing again.

If the tested bit is on, the routine checks if this was the required bit. If it was, the routine returns to the caller indicating the bit was already on when tested.

If the tested bit is on but it is not the required bit, the bit is turned off in the variable containing the elements contents and the routine continues to test the next highest bit.

This is all very complicated but a quick test during some values will show how it works.

Some people will notice that statement 590 is sometimes executed unnecessarily. It was felt that a GOTO command after statement 580 would not make the routine much faster and only uses up more memory.

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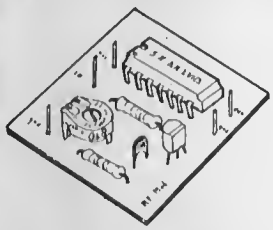

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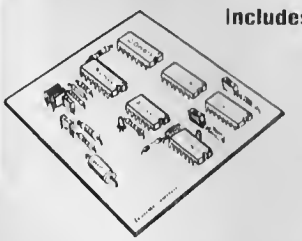

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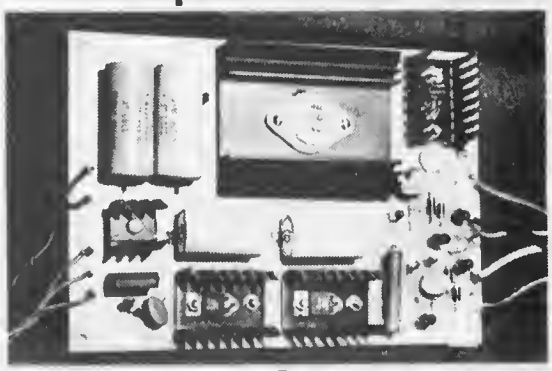

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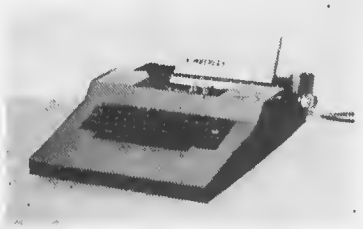

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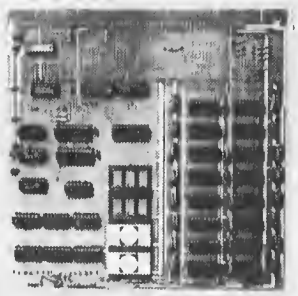

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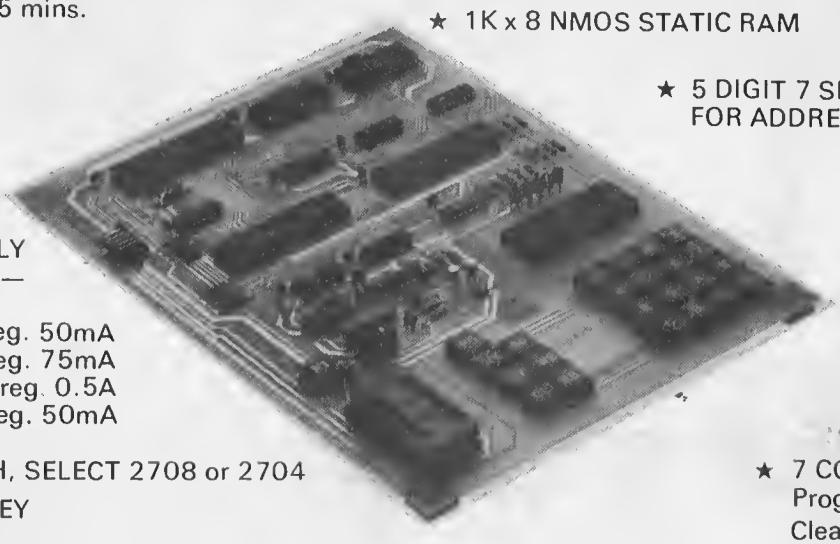

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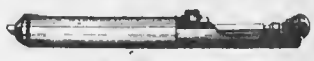

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